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Annual Summary of Technical Awareness in the Nonferrous Metals Industry

Battelle Columbus Labs, OH

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April 1979

ANNUAL SUMMARY OF TECHNICAL AWARENESS IN THE NONFERROUS METALS INDUSTRY

by

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FOREWORD

When energy and material resources are extracted, processed, converted, and used, the related pollutional impacts on our environment and even on our health often require that new and increasingly efficient pollution control methods be used. The Industrial Environmental Research Laboratory-Cincinnati (IERL-Ci) assists in developing and demonstrating new and improved methodologies that will meet these needs both efficiently and economically.

To perform this task, IERL-Ci must not only keep abreast of current and emerging industrial technology, but also of various aspects of commerce important to industrial segments under its purview. Maintaining such an awareness of the technological and business aspects of industry is no menial task. This summary report describes efforts designed to facilitate awareness of the nonferrous metals industry. The result has been the preparation of periodic awareness bulletins, examples of which are appended. The description of methodology contained in this report will be useful to agencies and persons involved in or contemplating formal means of assessing industrial status for other than the nonferrous metals industry. Further information on this subject may be obtained from the Industrial Pollution Control Division, Metals and Inorganic Chemicals Branch, of IERL-Ci.

David G. Stephan
Director
Industrial Environmental Research Laboratory
Cincinnati

ABSTRACT

The goal of this project was to pilot and refine methods and procedures for maintaining current awareness of technology and commercial trends in the U.S. nonferrous metal mining and manufacturing industry. The principal effort resulted in the publication of six bimonthly technical awareness bulletins during the first year. Items culled from the technical and trade literature were presented as news notes, brief patent and foreign technology abstracts, and, where the article content warranted, brief analytical summaries of pertinent technology. Examples of the product are appended.

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SECTION 1

INTRODUCTION

The intent of this project was to provide a means whereby the Metals and Inorganic Chemicals Branch of the Industrial Environmental Research Laboratory-Cincinnati (IERL-Ci) could maintain a timely cognizance of new and developing technology and operations in the nonferrous metals industry. The operational basis at the outset was a methodology recommended in Report No. EPA-600/2-76-303, Methodology for Assessing Environmental Implications and Technologies: Nonferrous Metals Industries.

The primary objective of this program was to prepare an analytical commentary on technology within the nonferrous metals industry that might affect the impact of that industry on the environment. Chief goals during the first year of this program were (a) the piloting of methodology, (b) the development of a suitable information bulletin format, and (c) the submission of six bimonthly awareness bulletins to the U.S. Environmental Protection Agency (EPA). (see Appendix).

Information and data were to be obtained primarily through a timely review of the current open literature. A recommended list of 44 publications ranging from daily to quarterly periodicals, and involving about 230 individual issues for each 2-month period, were to be searched. Supplementing periodicals as the primary sources of information was attendance at selected conferences, review and purchase of pertinent conference preprints and special publications, abstract searching, and personal contacts.

Although selected foreign language journals were included in the recommended list, only titles and abstracts (where available) printed in English were perused. Translation was not included within the scope of this program.

Some changes in methodology and strategy were indicated and instituted during the course of this project. The report describes the methods and procedures found to be most effective in providing a medium for monitoring awareness.

SECTION 2

CONCLUSIONS AND RECOMMENDATIONS

In general, the effectiveness of technology coverage during the first year of this project was judged to be fair. Coverage of English language literature was generally very good. Areas of weakness were the foreign literature and conference proceedings. Steps have already been taken to correct the weak coverage of the foreign literature. By using the methods described here along with some minor changes in technique, coverage of truly pertinent technology (excluding foreign patents) should be effective enough to include 80 to 90 percent of the pertinent items in the abstract data bases studied.

News items are not normally covered by the technical abstract services, so there is no convenient way of assessing the coverage effectiveness; but for news clips of major import, several publications often report the same item, indicating that coverage is probably good.

In conclusion, the methodology adapted for this task of maintaining awareness of technology and events in the nonferrous metals industry is believed to provide the intended coverage. A few weak coverage areas are recognized and will be corrected in continuing activities. Coverage of foreign literature and conference proceedings will receive more emphasis. We recommend that this activity be continued.

SECTION 3

METHODS

To facilitate collection of data for each bimonthly bulletin, incoming journals and periodicals were set aside by the libraries at Battelle for a few hours after receipt each day. These were searched daily by the project staff. Selections were made by scanning the tables of contents of technical journals and appropriate scanning of popular journals and news periodicals. Items and articles of possible interest were noted and clipped or reproduced for more detailed review, culling, sorting, and analysis. On the average, about 200 publications (roughly 1,000 issues in a 2-month period) were scanned in this way.

The publications screened in this manner included most of the recommended list from EAP-600/2-76-303. In addition, many other publications were retrieved from publications not on the recommended list.

In the preparation of each bulletin, the collected material was reviewed in detail. Items judged to describe new technology or news pertinent to the nonferrous metals industry, and particularly items that related to possible local or generic changes in environmental quality, were set aside for analysis and summary. Items that lacked novelty, were out-of-date, or could not be conceived to have significant environmental implications were rejected at this point.

News items were grouped according to topic, summarized, and referenced for reporting. Technical articles were reviewed in detail and abstracted, with comments on probable environmental implications where this was appropriate, in the Technology and Trends Section. Each selected article summarized as a Technology and Trends item was indexed according to a three-tier system defining the material, process, and area of potential environmental impact, insofar as these were applicable. Table 1 lists the index terms and describes the index order. This index may be used for the ready retrieval of information according to the index classification.

Patent abstracts were reviewed to extract technical information, which was then briefly summarized in technical rather than legal language. Abstracts of foreign language articles were reviewed and often rephrased for more appropriate syntax. The manuscripts were assembled, typed, edited, collated, and submitted to the EPA/IERL project officer. The draft bulletins were reviewed by the project officer and preprinted by IERL for distribution to selected government offices and industrial concerns with known interest in the subject matter. Upon conclusion of the year's activity, the bulletins were formally reviewed and assembled as a single annual review document. This is included as the Appendix to this report.

TABLE 1. INDEXING STRATEGY AND TERMS FOR TECHNOLOGY AND TRENDS SUMMARIES

Metals

1. Cu (and As, Se, Te)*
2. Pb, Zn (Sb, Cd, Tl)
3. Al (Ga)
4. Ti (Zr, Hf)
5. Mo (Re, Sn)
6. Rare Earths and Y
7. Be
8. Hg
9. Ag, Au, Pt, Pd
10. W
11. V, Cr
12. Cb, Ta
13. Ni (Co, Mn)
14. Mg
15. Multiple
16. Unspecified

Process

.1 Mining (P)†
.2 Beneficiation (P)
.3 Smelting/Extraction (P)
.4 Refining (P and S)
.5 Ingot Melting (P and S)
.6 Preparation (S)
.7 Smelting/Extraction (S)
.8 General Recycling (S)
.9 Multiple (P and S)

Environmental Concern

.1 Air (Human)
.2 Air (Ecology)
.3 Water (Human)
.4 Water (Ecology)
.5 Solid (Human)
.6 Solid (Ecology)
.7 Noise
.8 Multiple
.9 Not Determined

Example: 5.3.4

This article deals with the extraction of molybdenum (or rhenium or tin) values as it may impact ecological effects of aqueous effluents.

---

* ( ) = common byproducts

† ( ) = primary or secondary

A summary of returns from technical and commercial literature perusal is given in Table 2 for those publications that yielded items of potential interest. Of 740 items separated for further study, about two-thirds were actually used in preparing the awareness bulletins. The rest were discarded when review indicated the item or technology was not new, not pertinent to the nonferrous metals industry, or not significant to environmental considerations. About three-fourths of the collected items came from about one-fourth of the most productive publications.

TABLE 2. SUMMARY OF OPEN LITERATURE FINDINGS, MAY 1977 TO APRIL 1978

Publication title	Publication frequency	Number of articles of interest	Number of items used		
			News items	Technology summary	Abstracts
J. Air Pollution Control Association	Monthly	1	-	1	-
American Metal Market	Daily	108	52	9	-
American Scientist	Bimonthly	1	-	1	-
Proc. Australasian Inst. Mining and Metallurgy	Monthly	3	-	2	-
Australian Mining	Monthly	1	-	1	-
Canadian Chemical Processing	Monthly	3	-	3	-
Canadian Inst. of Metals Bulletin	Monthly	5	-	3	-
Canadian Mining Engineer	Monthly	1	1	-	-
Canadian Mining Journal	Monthly	1	-	1	-
Chemical and Engineering News	Weekly	7	2	1	-
Chemical Engineering	Bimonthly	12	4	4	-
Chemical Processing	Monthly	3	2	1	-
Chemical Week	Weekly	12	4	-	-
Chemistry in Australia	Monthly	1	-	1	-
Chemistry in Canada	Monthly	1	-	-	-
Chemistry and Industry	Biweekly	1	-	1	-
Chemtech	Monthly	1	-	-	-
Electronic Progress	Quarterly	1	-	-	-
Engineering and Mining Journal	Monthly	34	18	6	-
Environmental Science and Technology	Monthly	6	1	1	-
Environmental News		1	1	-	-
Erzmetall (German)	Monthly	26	-	-	21
Foundry Management and Technology	Monthly	1	-	-	-
Hitachi Review	Monthly	1	-	-	-
Hydrometallurgy	Bimonthly	2	-	1	-
Indian and Eastern Engineer	Monthly	1	-	1	-
Industrial Heating	Monthly	1	-	-	-

(Continued)

TABLE 2. (Continued)

Publication title	Publication frequency	Number of articles of interest	Number of items used: News items	Number of items used: Technology summary	Number of items used: Abstracts
Trans. Inst. of Mining and Metallurgy	Monthly	2	-	2	-
Iron Age - Metalworking International	Monthly	1	-	-	-
J. Water Pollution Control Federation	Monthly	1	-	1	-
Journal of Metals	Monthly	11	2	4	-
J. Occupational Medicine	Monthly	2	-	2	-
Light Metal Age	Monthly	4	2	-	-
Metal Bulletin	Semiweekly	9	3	-	-
Metallurgical Transactions B	Quarterly	1	-	1	-
Metal Progress	Monthly	1	-	-	-
Metall (German)	Monthly	1	-	-	-
Metals Week	Weekly	2	1	1	1
Metals and Materials	Monthly	2	-	2	-
Metalurgia Italiana (Italian)	Monthly	1	-	-	-
Mineral Industry Survey	Monthly	13	3	-	1
Minerals and Materials	Monthly	48	29	-	-
Mining Congress Journal	Monthly	26	11	3	-
Mining Engineering	Monthly	17	4	4	-
Mining Journal	Weekly	15	4	1	-
Mining Magazine	Monthly	12	-	4	-
Mining Record	Weekly	53	39	1	-
Modern Application News	Bimonthly	1	-	-	-
Modern Metals	Monthly	4	1	-	-
Neue Hutte (E. German)	Monthly	1	-	-	-
Northern Miner	Weekly	2	-	2	-
Pay Dirt - Arizona	Monthly	48	26	1	-
Pay Dirt - New Mexico	Monthly	24	17	-	-
Plating and Surface Finishing	Monthly	1	-	-	-
Pravda Ukrainy (Russian)	Weekly	1	-	-	1

(Continued)

TABLE 2. (Continued)

Publication title	Publication frequency	Number of articles of interest	Number of items used		
			News items	Technology summary	Abstracts
Precision Metals	Monthly	1	-	-	-
Rudi I Metale (Polish)	Monthly	12	-	-	9
Skillings' Mining Review	Weekly	30	18	6	-
Soviet News in Science and Technology	Monthly	2	1	-	-
Sulfur	Bimonthly	2	-	1	-
Technische Mitteilungen Krupp (German)	Monthly	1	-	-	1
Thirty Three	Monthly	4	1	1	-
Transactions of the National Institute for Metals	Monthly	1	-	1	-
Tsvetnye Metally (Russian)	Monthly	1	-	-	1
U.S. Patent Gazette	Weekly	118	-	-	84
Wall Street Journal	Daily	12	5	-	-
Water, Air, and Soil Pollution	Monthly	1	-	-	-
Wire Technology	Bimonthly	1	-	-	-
World Mining	Monthly	14	6	3	-
Total for 69 Publications	-	740	258	79	119

Collections made during the first 2-month period showed that detailed reports of technology were fewer in number than had been expected and that newsworthy items relating to business and regulatory concerns of the nonferrous metals industry were dominant in the collections. Accordingly, the awareness bulletin format was revised to include sections on news, patents, and technology of potential interest and utility to EPA. Also, because of the abbreviated nature of English abstracts in foreign language journals, a foreign technology section was later added.

In addition to the above primary functions, the following activities were pursued:

1. Abstracts of the Canadian Institute of Metals (CIM) August 1977 symposium in Vancouver, B.C., were reviewed, marked, and sent to the EPA project officer. (Preprints of selected papers were sought from CIM but were not available.)

2. A number of special publications were purchased for use in this program:

    - Arizona Pay Dirt (monthly)
    - New Mexico Paydirt (monthly)
    - Mining Record (weekly)
    - Lead and Zinc Update, 1978 (book)
    - Light Metals, 1978 (two-volume book).

3. The Annual Meeting of the American Institute of Mining, Metallurgical, and Petroleum Engineers in Denver, 1978, was attended by the principal investigator, and a report was sent to the EPA project officer. Several preprints were ordered, received, and reviewed.

4. Selected personal contacts were made to clarify some points of written papers or to check news items. The results were incorporated into the awareness bulletin comments and analyses.

5. Searches were made of the following data bases:

    - SSIE (Smithsonian Scientific Information Exchange), Topic HS45-08 - Metal Ore Extraction and Refining, April 1978
    - CHEMCON (Chemical Abstracts), April 1978
    - COMPENDEX (Engineering Index), April 1978.

SECTION 4

RESULTS AND DISCUSSION

Effectiveness of the technology coverage achieved by this study was judged by comparisons with the three data bases searched--SSIE, Chemical Abstracts, and Engineering Index. The usefulness of these abstract data bases was limited, however, because entries were generally not current.

The lag in abstract service postings is such that most are not listed until 8 to 13 months after publication in the case of the Engineering Index, and 10 to 16 months for Chemical Abstracts. Of the research projects listed in the SSIE data base (Metal and Ore Extraction and Refining Catalogue), 93 of 169 were pertinent to nonferrous metal and ore processing, but only four were current (April 1978). The rest had either been terminated recently or as many as 2 years ago. Some listed programs were obviously continuations of earlier studies, which were also listed. Several of these programs have already been reported in the open literature, and some have been the subject of awareness bulletins.

Results of the data base searches are nonetheless useful, despite their limitations. A categorical summary of SSIE-posted research pertinent to the nonferrous metals industry is useful for indicating areas in which this type of research is typically conducted (Table 3). The SSIE data base heavily emphasizes Federally funded programs performed by government agencies and universities (Table 4). A similar search of the COMAT (an interagency government committee on materials) data base on file at Battelle's Columbus Laboratories for the Federal fiscal year 1976 yielded half again as many programs as the SSIE data base. The COMAT programs have more emphasis on the environment because they include more U.S. Department of Health, Education, and Welfare programs pertinent to the nonferrous metals industry.

Searches of the Chemical Abstracts and Engineering Index data bases were conducted for nonferrous metallurgical processes with environmental implications. The searches were made on data base entries from January 1, 1977, to April 17, 1978 (the date the search was made). Returns of the searches are presented in Table 5.

Fifty-six percent of the possibly pertinent items from Chemical Abstracts was from periodicals covered in this grant; 26 percent was from foreign patent literature and foreign journals not covered by current searching; 7 percent was from conference proceedings not published in regular periodicals; another 7 percent was in one periodical available to the grant activity but not included in the searching (it will be in the future); and 4 percent was in the report literature. This result indicates that greater attention should

TABLE 3. SUMMARY OF SSIE CATALOGUE OF RESEARCH PROGRAMS RELATED TO METAL ORE EXTRACTION AND REFINING (APRIL 1978)

Material	Development of domestic resource	Improvement of energy efficiency	Amelioration of environmental problems	Improved process economy	Material recovery, recycle, and conservation	Education and basic research	Total number of projects
Aluminum	5	1	2	1	1	0	10
Copper	0	0	5	6	3	2	16
Lead	0	1	3	0	0	0	4
Zinc	0	2	2	3	1	0	8
Precious Metals	5	0	1	0	0	0	6
Ni/Co	6	0	0	0	0	0	6
Chromium	6	0	0	0	0	0	6
Toxic material	0	0	6	0	0	0	6
Other and unspecified	3	1	5	3	2	17	31
Total number of projects	25	5	24	13	7	19	93

TABLE 4. SOURCES OF FUNDS AND TYPES OF PERFORMING AGENCIES FOR SSIE-POSTED PROJECTS

Item	Number	Item	Number
Funding Source:		Performing Agency:	
Federal Government	88	Federal Government	57
Department of Interior	56	United States Bureau of Mines	55
National Science Foundation	24	Army Materials and Mechanics Research Center	1
EPA	6	Oak Ridge National Laboratory	1
Department of Defense	1		
National Oceanographic and Atmospheric Administration	1		
Industry	3	Universities	27
Local Government	1	Industry	4
Foreign	1	Foreign	1
		Other	4

TABLE 5. RETURNS OF DATA BASE SEARCHES FOR CHEMICAL ABSTRACTS AND ENGINEERING INDEX

Item	Chemical Abstracts	Engineering Index
Number of items	138	103
Weighted age of items, April 17, 1978	15.5 months	11.7 months
Number of items dated after May 1, 1977*	42	52
Number of applicable items†	27	30
Number of items dated after January 1, 1977	0	1

* Date on which the grant began.

† Title scan of items dated May 1, 1977, or later indicated that this was the number of items pertinent to the scope of this grant.

be paid to worldwide conferences, and attempts should be made to obtain proceedings from such conferences where they or the abstracts are available in English. The purview of foreign journals during the first year was less than desired, and steps have been taken to remedy this situation. However, considerable input to Chemical Abstracts derives from foreign patent literature. The expense of monitoring and assessing the foreign patent literature would be out of proportion with the value accrued. On the basis of this evaluation, the target coverage for this project relative to the eventual Chemical Abstracts postings should be about 70 percent.

The Engineering Index appears to concentrate more heavily on the indexing of technical periodicals than does Chemical Abstracts. About 80 percent of the possibly pertinent items returned by the search of this data base were derived from publications covered by this grant. Thirteen percent of the Engineering Index yield was from foreign journals (or translations therefrom) not covered by this study. The remainder was from special conference proceedings and the report literature.

SECTION 5

USEFULNESS TO EPA

The Environmental Protection Agency has comprehensive legislative and judicial mandates for regulating all pollution resulting from the production and use of industrial chemicals and products. Emphasis is being placed on toxic and hazardous pollutants. To aid EPA's Office of Research and Development (ORD) focus its future control technology research and development efforts on those pollution problems which have the greatest health and ecological impacts, an approach has been developed for simultaneously assessing the total environmental impact of industrial pollution discharge to the air, water, land, and to municipal treatment systems. This multimedia approach necessarily involves the active cooperation and participation of the appropriate industrial and EPA components to define the industry, identify the most pressing environmental problems, and structure development programs on promising existing or emerging technologies. Pertinent research projects in the private and public sector (both foreign and domestic) continue to advance the state of the art of control and abatement technologies. Results of these efforts are often reported in trade journals, magazines and conference proceedings. Without some attempt to centralize this flow of information, duplication of effort or reinvention of existing information would likely exist.

From ORD's perspective, an immediate need to maintain cognizance of the development of control technology by industry exists. This is apparent when technology application studies are initiated to address either a specific or a generic pollution problem. Promising new or novel approaches are important and welcome. The best current solution, rather than just a possible solution, can then be resolved. This necessitates maintaining an up-to-date data base that evolves from public and private inputs and the technical literature to create a more complete picture. This need is addressed by the bulletin in that the information in the public domain is screened for relevance to a particular program for technical soundness and directed to the appropriate individuals. Specifically, the Metals and Inorganic Chemicals Branch is developing a data resource center that will use the bulletins' findings for review, analysis, and development of current and proposed nonferrous metals program directions.

There are ancillary benefits accruing to the nonferrous research and development program as well. Technical personnel often read many publications to remain abreast of current technological developments. To approach a complete review would be time consuming if each individual in an operational group were to perform a comprehensive review. In addition, attendance at relevant conferences is not always possible. The bulletin, therefore, becomes a time-saving device providing a complete and timely summary of the technical literature at a comparatively modest price. The EPA's nonferrous research and development program also gains visibility through the bulletin by informing its user group of current projects and products. Constructive criticism and suggestions often result which aids in program direction, provides new initiatives, and encourages industry participation.

APPENDIX
COMPILATION OF TECHNICAL AWARENESS BULLETINS
July 1977--May 1978

TECHNICAL AWARENESS BULLETIN--NONFERROUS METALS

This is a regular publication of the USEPA's Metals and Inorganic Chemicals Branch, Office of Research and Development, designed to spotlight selected events and concerns of the nonferrous metals industry.

HIGHLIGHTS

- *Woes continue in the copper industry as low prices, imports, and large inventories overhang the domestic supply situation. Proposed stockpile changes may provide some temporary relief, but the projected crippling effects of environmental requirements indicate that conditions will continue to deteriorate. (Items 8, 11)*
- *Domestic zinc producers are also hard hit by depressed conditions, and additional closures and cutbacks are announced. Authorities question whether the domestic zinc industry can survive. A 5-year survival plan has been presented to the International Trade Commission (Items 26, 27)*
- *The State of Arizona and its copper smelting industry are agitated by the recent USEPA announcement of The Arizona Plan, the preparation of which appears to have ignored the State submission. Legal dissention appears to be in the offing. (Item 31)*
- *Although the domestic lead industry presently enjoys bullish conditions, the rumored 1.5 $\mu g/m^3$ ambient air standard would have dire consequences. (Item 12)*
- *Sustained market vigor for precious metals continues to spark new and renovated mining and milling activities for silver and gold. (Item 19)*

Individually contributed news items may be submitted to the Metals and Inorganic Chemicals Branch, Industrial Environmental Research Laboratory, USEPA, 5555 Ridge Avenue, Cincinnati, Ohio 45268, 513-684-4491.

Prepared by Battelle's Columbus Laboratories under EPA Grant R805095.

NON-FERROUS METALS INDUSTRIES

IN THE NEWS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Aluminum

(1) Construction has begun on a 91,000 tpy potline expansion at the Eastalco primary aluminum smelter of Alumax Inc. at Frederick, Maryland. This will expand the Frederick smelter capacity to 267,000 tpy. The new potline addition will be owned jointly by Alumax and Mitsui and Co. Ltd. Construction is scheduled for completion in 1980. Howmet Aluminum Corp. has the option of becoming a part of the joint venture in 1982.

Copper

(2) The addition of a new dumping pocket with a 350-ton capacity, and an 8 x 40-foot pan feeder will provide an improved and controlled 2000 tph flow of ore to the crusher at Kennecott's Ray Mines Division in Arizona.

(3) Occidental Minerals Corp. has suspended indefinitely work on its copper project near Cerillos, New Mexico, citing the depressed copper market and the high cost of meeting state environmental requirements as factors. Another contributing factor may have been a petition by environmentalists who were expressing concern that the in situ leaching operation might be a threat to the local water table and its purity.

(4) Hanna Mining Co. has raised the estimated reserve by 40 percent to 350 million tons of 1 percent copper ore at the recent discovery near Casa Grande, Arizona. Drilling will continue through 1978, along with intensive geological, metallurgical, and environmental studies, to determine the feasibility of a large-scale operation by the joint venture of Hanna and Getty Oil.

(5) The Magma Copper Co. is converting the furnaces of its San Manuel smelter to coal firing. The first furnace conversion is slated for completion by July 1, 1978, but must await installation of electrostatic precipitators before its use, probably in mid-1979. Natural gas shortages and the increasing cost of fuel oil is given as the reason for several other copper producers contemplating a similar change to coal.

(6) Effective May 1, 1978, the Anaconda Co. will shut down its Anaconda, Montana smelter for 2 months for repair of an electric furnace. Sufficient anode copper is stockpiled to meet deliveries.

Kennecott has closed its Nevada Mines Division for at least 3 months and the Baltimore copper refinery for 3 months effective May 1. Oversupply in the copper market resulting in depressed prices was the stated reason for these closures.

(7) Approximately 5 million tons of copper contained in ore assaying 0.2 to 0.4 percent copper has been defined in exploration north of Safford, Arizona, by the Kennecott Corp. Efforts for the past 7 years have been devoted to in situ piloting of this deposit. The pilot mining study is not now economically feasible. No additional details are available.

(Note: Through personal contact, it has been learned that Kennecott is cancelling its in situ mining program.)

(8) A recent study by Arthur D. Little, Inc. for the U.S. EPA concludes that the copper industry will be crippled by environmental requirements. The Clean Air Act and Water Pollution Control Act will cost the domestic copper industry 21,000 to 28,000 jobs, force prices up 30 to 39 percent, reduce production 25 to 33 percent, raise copper imports by 18 to 21 percent, and reduce total domestic consumption by 8 to 11 percent by 1987.

(9) Kennecott, Phelps Dodge, Anaconda, Asarco, Magma, Inspiration, Duval, Cities Service, Copper Range, Cyprus, Hecla, and Ranchers recently filed a petition with the International Trade Commission stating that temporary import relief is necessary to remedy the injury to the copper industry caused by increased copper imports. The Commission must now prove that the producers have been injured and qualify for protection under the law.

(10) A decision was made to establish a "standing intergovernmental copper body" by the Third Preparatory Meeting on Copper which met in Geneva on January 30-February 3, 1978. This group will continue to examine the copper situation and search for solutions to identified problems.

(11) In a move to diminish the domestic glut of copper, a bill introduced in the House of Representatives by Rep. Udall and concurrently in the Senate by Sen. De Concini calls for the disposal of up to 45,000 long tons of tin from the national stockpile. Proceeds from up to 26,000 tons are to be used to finance purchase of up to 225,000 short tons of copper, the remaining tin receipts to be used to finance other strategic materials purchases. No funds for the purchase of the copper are included in the supplemental 1978 or fiscal 1979 budget requests; thus, the only method of acquiring the copper is by the sale of tin or tungsten, or through direct barter. It is believed that barter or the swaping of tin and/or tungsten for copper would expedite the acquisition of the copper without incurring the delays of the appropriations procedure.

The Carter administration has given its full and unqualified endorsement to the Udall-De Concini legislation.

Lead

(12) Amax has no specific plans to expand lead and zinc production, although the demand for lead has been excellent with a 2 percent growth expected by 1979. A recent report that the ambient air standard of 1.5 micrograms per cubic meter would close down about 80 percent of the domestic lead smelting and refining capacity is thought to be an accurate assessment. The Buick, Missouri, lead facility of Amax cannot meet this standard as the technology for compliance with the standard apparently doesn't exist.

(13) Construction has begun on a $3 million lead strip fabricating plant by the St. Joe Lead Co. near its lead smelter in Herculaneum, Missouri. The facility is slated to go into production in late 1979, with an initial capacity of 30,000 tons per year to serve the growing maintenance-free battery market.

Molybdenum

(14) Further geological exploration has increased the estimate of molybdenite mineralization to 165 million tons at Amax's Mt. Emmons project near crested Butte, Colorado. An estimate of 130 million tons was reported in "In the News" for September/October, 1977.

(15) In order to coordinate all activities in reviewing and issuing permits and drafting environmental impact statements at Climax's Mt. Emmons molybdenum project near Crested Butte, Colorado, the State of Colorado has proposed "The Colorado Venture". This pioneering process would identify all Federal, State, and local agencies that should be involved in the planning and conceptual process of the mine development.

Nickel

(16) The Port Nickel Refinery of Amax, Inc., near New Orleans, Louisiana, has saved 35,000,000 kilowatt hours of electricity per year by bypassing a $1.8 million electric arc furnace used to melt crushed copper-nickel matte.

Precious Metals

(17) One and a half million dollars has been invested to revive the Blazing Star Gold Mine in California's Mother Lode country. Apparently, the previous owners had only mined down to the oxidized (free gold) level. A 13.5-foot-wide vein at a depth of 1600 feet has assayed 17 ounces of gold per ton of ore, in contrast to the 7 ounces per ton of the former mining operation.

(18) The Homestake Mining Company's gold mine in Lead, South Dakota, has recently completed and placed into operation a $14 million project for tailings disposal and environmental enhancement. This brings to an end the

practice of discharging mine tailings and wastewater pollutants into the rivers and streams of the Black Hills.

(19) The high market price of gold continues to induce many companies to prospect for gold as well as silver with increasing intensity. The Bueno Coeur d'Alene Company has drilled 2200 feet, near Mullan, Idaho, into a vein assaying 15.2 ounces per ton of silver, while its exploration near Boulder, Colorado, has an excellent potential for reserves of telluride gold. Placer mining for gold will begin in 60 days by the Boardman Gold Mining Co. near the Columbia River at Boardman, Oregon. Ladd Enterprises, Inc. will begin placer mining its claims in Mineral County, Nevada, at the rate of 3000 tons per week. An estimated 100 million tons of placer material averages 0.06 ounce per ton of gold and 0.3 ounce per ton of silver. Gold Placers, Inc. intends to return its Liberty gold placer property to production this year because of the discovery last year of a number of gold nuggets in the old channel of Liberty Creek near Ellensburg, Washington.

(20) Approximately 30 million tons of sulfide ore mineralization is indicated by exploratory drilling in Aroostook County, Maine, by the joint venture of the Superior Oil Co. and the Louisiana Land and Exploration Co. At a depth of 108 feet, a deposit averaging 350 feet in thickness assays 3.38 percent Zn, 0.11 percent Cu, 0.861 ounce Ag and 0.0206 ounce Au per ton for one ore type, and 1.64 percent Cu, 0.219 percent Zn, 0.2415 ounce Ag, and 0.0074 ounce Au per ton for a second type of ore.

Sea Nodules

(21) The SS Glomar Explorer will be used later this year to explore ways of mining manganese nodules on the ocean floor southeast of Hawaii. The government-owned ship (formerly owned by Howard Hughes) is under a 3-year lease by Global Marine Development, Inc., and later will be used by a consortium headed by Lockheed.

(22) What to do with a possible 10,000 tons per day waste from sea nodule processing has been given considerable thought in the Puna district on the island of Hawaii. This is the most likely location for a processing plant of sea nodules. The possibility exists that the residue could be used to cover lava flows as a substitute top soil for agriculture use.

Zinc

(23) Low prices, tight markets, imports, and outmoded plants continue to plague the domestic zinc industry. Additional facility closures and production cutbacks are the result. For example, the Bunker Hill Company closed its Pioche, Nevada, mine and mill on March 31, 1978, for an indefinite period. The declining price of zinc was given for the closure. The Pan American Mine and Caselton concentrator was currently producing about 400 tons of zinc metal monthly.

(24) During the last week of April, 1978, the production at the Corpus Christi, Texas, zinc refinery of Asarco, Inc. was curtailed to 50 percent of capacity for an indefinite period. Other zinc plants which have closed or are operating at reduced capacity are Amax, Inc.'s Sauget, Illinois, electrolytic refinery, closed down; the Bear Hole mine of Eagle-Pitcher, near Shullsburg, Wisconsin, closed down; St. Joe Zinc Co.'s Monaca, Pennsylvania, verticle retort plant, operating at 65 percent capacity; New Jersey Zinc Co.'s Palmerton, Pennsylvania, vertical retort plant, operating at 72 percent capacity; and Bunker Hill Co.'s Kellogg, Idaho, electrolytic refinery, operating at 70 percent capacity.

(25) Operation of the zinc fuming plant of the Bunker Hill Co.'s lead smelter in Kellogg, Idaho, was resumed in early March after a 39-day closure due to poor market conditions. Jersey Miniere Zinc Co. will bring its Clarksville, Tennessee electrolyte refinery with a capacity of 90,000 tons of zinc per year on stream this fall, rather than in August, as had been planned.

(26) The zinc industry appears to be at a crossroads with the survival of the industry at stake, according to some producers. Two major problems face the producers: (1) outmoded facilities and (2) declining zinc consumption. The outmoded plants have caused a decline of 50 percent in zinc production since 1970, with the gap filled by imports. A 50 percent cutback in the use of zinc in the 1978 model cars has compounded the problem of inefficient plants.

(27) In an attempt to curb imports, the zinc producers have presented to the International Trade Commission a 5-year plan. The plan recommends a quota of 350,000 tons the first year (beginning September, 1978), beyond which a $0.07 tariff on each pound of slab zinc would be imposed. Each year the quota would be raised, until it reached 525,000 tons in 1982. The quotas are based on a domestic consumption of 1,140,000 short tons during the first year, and a 2.5 percent annual growth rate through 1982.

Miscellaneous

(28) American Metallurgical Products Co. will produce 3 to 5 million pounds of mischmetal and other rare earth metals at its new $1 million plant, which began production in March, 1978, at Sprindale, Pennsylvania.

(29) The entire issue of the Journal of Metals for April, 1978, is devoted to a review of extractive and process metallurgy, including over 500 references. The details will be reported in a future Awareness Bulletin.

(30) Residential and commercial heat as a byproduct of the metals industry? Heat wasted at Intalco's Ferndale, Washington, aluminum reduction plant could heat as many as 6,500 homes within a 20-mile radius, according to a study by Intalco, Rocket Research, and Bonneville Power. An estimated 2000 megawatts of potentially marketable heat are wasted by domestic aluminum plants alone. Federal funds will be requested to pilot a heat collection and distribution system.

(31) The Arizona Plan of the U.S. EPA to regulate smelter emissions became effective on February 3, 1978. Many legal suits and battles are anticipated as it is impossible for any copper smelter in Arizona, except the Phelps Dodge Ajo plant, to meet the air quality standards, now or in the foreseeable future. The state-adapted plan under which the smelters are now operating was submitted to the EPA in January, 1977, for review and comment, but was never acknowledged. This plan improved the air quality 75 to 80 percent in the past 2 years.

A Nonferrous Smelter Order passed as an amendment to the Clean Air Act last year allows a 10-year postponement of expensive new pollution controls for those companies who show the EPA they cannot afford the maximum emission controls.

(32) A hearing chaired by Rep. Udall of Arizona and Rep. Johnson of Colorado was held in Grand Junction, Colorado, on February 18, 1978, to consider repeal or reform of the General Mining Law. Attended by 200 persons, statements were made by 82 witnesses, two-thirds of whom urged leaving the present law intact or using an amended version of HR 5831 (the Ruppe bill backed by Rep. Udall and the American Mining Congress), if Congress was determined to pass some kind of a mine reform bill this session.

REFERENCES

(1) U.S. Bureau of Mines, Minerals and Materials, 1 (April, 1978).

(2) Arizona Paydirt, (464), 37 (February, 1978).

(3) New Mexico Paydirt, (10), 41 (March, 1978).

(4) Skillings' Mining Review, 67 (14), 17 (April 8, 1978).

(5) Engineering Mining Journal, 179 (3), 236 (March, 1978).

(6) American Metal Market, 86 (75), 10 (April 18, 1978).

(7) Arizona Paydirt, (464), 50, 51 (February, 1978).

(8) Arizona Paydirt,(465), 10, 11 (March, 1978).

(9) U.S. Bureau of Mines, Minerals and Materials, 2 (March, 1978).

(10) U.S. Bureau of Mines, Minerals and Materials, 10 (February, 1978).

(11) Arizona Paydirt, (465), 12 (March, 1978).
American Metal Market, 86 (58), 1, 7 (March 24, 1978).

(12) American Metal Market, 86 (68), 8 (April 7, 1978).

(13) The Wall Street Journal, LVIII (98), 11 (March 6, 1978).

(14) The Mining Record, 89 (12), 3 (March 22, 1978).

(15) U.S. Bureau of Mines, Minerals and Materials, 47 (March, 1978).

(16) World Mining, 31 (3), 122 (March, 1978).

(17) The Mining Record, 89 (16), 1 (April 19, 1978).

(18) U.S. Bureau of Mines, Minerals and Materials, 59 (February, 1978).

(19) The Mining Record, 89 (9), 1 (March 1, 1978).
The Mining Record, 89 (8), 1 (February 22, 1978)
The Mining Record, 89 (12), 1 (March 22, 1978).
Engineering Mining Journal, 179 (3), 240 (March, 1978).

(20) Skillings' Mining Review, 67 (14), 19 (April 8, 1978).

(21) Arizona Paydirt, (464), 12 (February, 1978).

(22) U.S. Bureau of Mines, Minerals and Materials, 53 (February, 1978).

(23) The Mining Record, 89 (12), 1 (March 22, 1978).
American Metal Market, 86 (50), 20 (March 14, 1978).

(24) The Mining Record, 89 (14), 1 (April 5, 1978).
American Metal Market, 86 (65), 2 (April 4, 1978).
Engineering and Mining Journal, 179 (4), 153 (March, 1978)

(25) Arizona Paydirt, (465), 35 (March, 1978).
American Metal Market, 86 (56), 8 (March 22, 1978).

(26) American Metal Market Lead and Zinc Supplement, 86 (66), 4A, 15A (April 5, 1978).

(27) American Metal Market, 86 (57), 1, 8 (March 23, 1978).

(28) U.S. Bureau of Mines, Minerals and Materials, 7 (March, 1978).

(29) Journal of Metals, 30 (4), 10-47 (April, 1978).

(30) Chemical Week, 122 (13), 10 (March 29, 1978).

(31) Arizona Paydirt, (464), 1, 4, 5 (February, 1978).

(32) The Mining Record, 89 (8), 1 (February 22, 1978).

RECENT PATENTS

4,073,641
SELECTIVE REDUCTION OF NICKEL ORE WITH A LOW NICKEL CONTENT
Jean Montanteme, Andre Greffe, and Francois Grandjacques, assignors to Societe Francaise d'Electrometallurique, Paris, France

(A method for selective reduction of nickel from ore or slag, the novel feature of which appears to be blending the reducing agent with an inert carrier, with the resulting volume being no less than one-fourth of the finally blended ore plus reducing mass charge. This appears to be a scheme to obtain superior dispersal of a solid reductant in a smelting charge to allow electric-furnace smelting.)

4,073,646
PROCESS OF SMELTING SULPHIDIC COPPER ORE CONCENTRATES
Walter Fritsch and Gerhard Melcher, assignors to Klockner-Humboldt-Deutz Aktiengesellschaft, Germany

(A method for coupling roasting and reverberatory smelting of sulfide copper ore wherein roaster offgas with its sensible heat is oxygen enriched and mixed with the reverberatory fuel and roasted concentrate is continuously introduced through the reverb flame to effect some degree of flash smelting. The SO_2- enriched reverb offgas would presumably be amenable to acid manufacture.)

4,076,605
DICHROMATE LEACH OF COPPER ANODE SLIMES
Edward A. Bilson, assignor to Inspiration Consolidated Copper Company, Morristown, New Jersey

(Copper anode slimes are leached with acid dichromate to recover copper values in solution. Selenium is precipitated with cement copper, and dissolved copper is recovered by electrowinning.)

4,078,917
EXTRACTION OF ANTIMONY TRIOXIDE FROM ANTIMONY SULFIDE ORE
Rollan Swanson, Santa Monica, California

(A hydrometallurgical process using alkanol solutions of sodium or potassium hydroxide to extract antimony from sulfide ores in the absence of air. On standing, the filtered pregnant liquor dissociates to yield Sb_2O_3 which is further purified.)

4,078,918
METHOD FOR PRECIOUS METAL RECOVERY
Craig A. Perman, Waterloo, Iowa

(Ammoniacal leaching of a source containing silver, mercury, or palladium returns a solution containing the metals as amine complexes. Treatment of the solution with ascorbic acid or a salt thereof precipitates the metals in elemental forms that are readily filtered.)

4,078,993
PROCESSES FOR FLOTATION OF MINERAL SUBSTANCES
Robert M. Griffith, Christopher Parkinson, and Ronald A. Palmer, assignors to Allied Colloids Limited, Bradford, England

(The use of an aldehyde with a compound containing two to six groups of amine or amides in flotation is claimed to selectively depress pyrite, pyrrhotite, and sphalerite from metalliferous sulfides or oxidized sulfide ores. Perhaps useful in treating lead-zinc ores?)

4,080,420
LEACHING OF TUNGSTEN VALUES FROM TRI (ALKALINE EARTH METAL) TUNGSTATE
Hans Peter Kasserra, Denis Bertram Kelly, and Isaac Obadia, assignors to Du Pont of Canada Ltd., Montreal, Canada

(An extraction process for tungsten wherein the scheelite or wolframite concentrate is calcined with an excess of limestone, e.g., to form water-soluble tricalcium tungstate, then extracting with a warm salt solution, e.g., sodium carbonate, etc., to yield soluble sodium tungstate and insoluble calcium carbonate, e.g., and separating soluble from insoluble matter.)

4,080,418
EXTRACTION OF COBALT, COPPER AND NICKEL VALUES FROM AMMONIACAL SOLUTIONS WITH CHELATING EXCHANGE RESINS OF RESTORED CAPACITY
John R. Carlberg, assignor to Amax Inc., Greenwich, Connecticut

(Extraction of amine complexes of nickel, copper, and/or cobalt with a chelate exchange resin, polymeric ar-vinylbenzylamino dicarboxylic acid, stripping with a mineral acid, and regenerating the resin as necessary with an aqueous alkaline solution of a halo salt of water-soluble carboxylic acid.)

4,081,506
METHOD FOR RECOVERING NON-FERROUS METALS FROM HYDRO-THERMAL SLIME
Peter Proplesch and Erich Zimmer, assignors to Kernforschungsanlage Julich Gesellschaft mit beschrankter Haftung, Julich, Germany

(A method for recovering metal values such as Fe, Zn, Cu, and Ag from hydrothermal slimes comprising mixing the debrined slimes with 5 to 15% sulfur, sulfate-roasting part at 400-450 C and extracting soluble sulfates with water, oxide-roasting the rest at 350-400 C and extracting the metal values with H_2SO_4 produced from the roaster offgas from both stages.)

4,082,542
COPPER PRECIPITATE AGGLOMERIZATION PROCESS
David B. George, assignor to Kennecott Copper Corporation, New York, New York

(A method for prerefining impure copper precipitates containing up to 15 percent copper and 2 percent sulfur. The precipitate is moistened with water, pelletized, and fed to a reduction kiln operating at 700 C or greater where oxygen and sulfur contents are reduced to 1 percent or less, and the pellets are upgraded sufficiently for treatment in a final refining furnace.)

4,082,629
HYDROMETALLURGICAL PROCESS FOR TREATING METAL SULFIDES CONTAINING LEAD SULFIDE
Edward F. G. Milner, Ernest G. Parker, and Godefridus M. Swinkels, assignors to Cominco Ltd., Vancouver, Canada

(An elaboration of a ferric chloride leach process for separating lead and other metal values from complex lead sulfide concentrates. Lead is converted to solid chloride, extracted with brine in multiple stages, crystallized, mixed with NaCl, fused, and electrolyzed to metal. By-product streams depicted by a flowsheet include ZnS, $ZnSO_4/FeSO_4$, and two sulfide mixtures, gold-free and gold-containing Ag/As/Bi/Cu/Sb sulfides.)

4,082,832
TREATMENT OF RAW MATERIALS CONTAINING TITANIUM
Morio Watanabe and Sanji Nishimura, assignors to Solex Research Corporation, Osaka, Japan

(A hydrometallurgical method for separating and extracting titanium and other metal values from titaniferous material which may also contain V, Mn, Cr, and Nb. The material is first dissolved in sulfuric acid. Hydrated ferrous sulfate is precipitated, and the solution is progressively and selectively purged of the various metal ions by liquid-liquid extraction with a series of LIX agents.)

4,083,920
TREATMENT OF TRI(ALKALINE EARTH METAL) TUNGSTATES WITH ACIDS
Stephen Peter Beaton and Hans Peter Kasserra, assignors to Du Pont of Canada Limited, Montreal, Canada

(Similar to 4,080,420. Wolframite is calcined to form, e.g., tri-calcium tungstate, but scheelite is reduction roasted to form a mixture of, e.g., tri-calcium tungstate and tungsten powder. Products are leached in HCl, HNO_3, or mixtures of these to dissolve impurities, retaining the tungsten values in the solid residue. Sheelite-derived values are treated with NH_4OH to return soluble ammonium tungstate.)

4,083,921
PURIFYING MOLYBDENUM FLOTATION CONCENTRATES
Rolf Jurgen Wesely, assignor to Kennecott Copper Corporation, New York, New York

(Treatment of molybdenum flotation concentrates to remove copper, iron, and lead impurities. Claims cover a low-temperature chloride roast followed by an oxidizing chloride leach at temperatures no less than 70 C, and separating the solution containing metallic impurities from the molybdenum-rich residue.)

4,083,927

CONTROLLED CARBO-CHLORINATION OF KAOLINITIC ORES

Ronald Wyndham, assignor to Toth Aluminum Corporation, New Orleans, Louisiana

(Preferential carbo-chlorination of alumina contained in kaolin is achieved by roasting the kaolin to drive off water of hydration, then carbo-chlorinating in the presence of boron chloride, which suppresses the chlorination of silica.)

FOREIGN TECHNOLOGY

(The articles listed are from foreign-language journals, with titles and abstracts printed in English.)

A. Kuivala, J. Poijärvi: "Removal of Mercury and Selenium From Roaster Gases"
Erzmetall, Vol. 30 (1977), No. 12, 555-558 (German)

The recovery of mercury and selenium, and the production of 40 to 50 percent sulfuric acid from roaster gases of the Kokkola zinc plant of Outokumpu Oy is described.

N. Eresen, R. Kammel: "Investigations About the Extraction of Nickel From Limonitic Type Laterite Ores With Aqueous Solutions of Polyamines"
Erzmetall, Vol. 30 (1977), No. 12, 561-566 Part I (German)
Erzmetall, Vol. 31 (1978), No. 2, 75-81 Part II (German)

The extraction of nickel from lateritic ores, both limonitic (high iron) or garnierite (high magnesia and silica), by pressure leaching with an alkaline solution of polyamines is described. Phase transformation of goethite into hematite govern the leaching kinetics and mechanism.

B. Heide: "Purification of Zinc Concentrates by Reversing Flotation"
Erzmetall, Vol. 31 (1978), No. 1, 33-38 (German)

The Meggen flotation plant of Sachtleben Bergbau GmbH has improved selectivity between zinc blende and pyrite by the addition of sulfur dioxide at a pulp temperature of 80 C. With the pyrite retaining its flotability and the zinc blende almost completely suppressed, the zinc middling product is improved from 35 to 50 percent zinc. The testing of various xanthates is described.

L. Sivila, W. Wuth: "Volatilization of Tin by Top Blowing"
Erzmetall, Vol. 31 (1978), No. 2, 57-61 (German)

The results obtained by the use of the "Top Blowing" technique for recovery of tin from natural and artificial slags are described. Slag conditioning was obtained by the use of oxygen, propane, sulfur dioxide, and pyrite.

(The following articles of potential interest from a German journal contained no English abstracts.)

R. Kullmann, E. Pfeil: "Processing of Intermediate Products of Smelting Works in a Rotary Converter by Using the Oxygen Process"
Metall, Vol. 32 (March 1978), No. 3, 257-260

D. Liesegang: "Advanced Waste Gas Cleaning Process for Copper Refining Furnaces"
Metall, Vol. 32 (March 1978), No. 3, 272-273

G. Pommerening, A. Gerberding, H. Stodieck, and U. Harms: "Possibilities for the Processing of Selected Nonferrous Ores in Developing Countries - Part I" Metall, Vol. 32 (March 1978), No. 3, 278-281

TECHNICAL AWARENESS BULLETIN - NONFERROUS METALS

This is a bimonthly publication of the USEPA's Metals and Inorganic Chemicals Branch, Office of Research and Development, designed to spotlight selected events and concerns of the nonferrous metals industry.

HIGHLIGHTS

- *Power restoration permits resumption of aluminum production in the Pacific Northwest. (Item 1)*
- *Postmining restoration can leave the land in better condition than it was before the mining operation. (Item 8)*
- *Improved process controls and automation are gaining increased importance in primary copper operations. Cost-saving process efficiencies and improved environmental control are the result. (Item 8 and T&T abstracts 1.3.2)*
- *The conflicts between domestic mineral development and production and environmental constraints will be among the issues addressed by a cabinet-level commission to investigate and analyze nonfuel mineral policies. (Item 9)*
- *Nickel has joined copper and zinc as a commodity with a depressed market/price structure; two domestic operators have curtailed production in the face of record-high producer inventories. (Item 16)*
- *The promise of continued increase in gold prices is sparking renewed activity in exploration and reopening of old mines where yellow metal operations may be profitable. (Item 17)*

Individually contributed news items may be submitted to Mr. Fred Craig, Metals and Inorganic Chemicals Branch, Industrial Environmental Research Laboratory, USEPA, 5555 Ridge Avenue, Cincinnati, Ohio 45268, 513-684-4491.

Prepared by Battelle's Columbus Laboratories under EPA Grant R805095.

NON-FERROUS METALS INDUSTRIES

IN THE NEWS

Aluminum

(1) Aluminum potlines in the Pacific Northwest, idle for almost a year because of power curtailment resulting from the drought in the area, are being brought back on stream. The companies affected and the location of the potlines where the Bonneville Power Administration is restoring power are: Reynolds, in Troutdale, Oregon, and Longview, Washington; Kaiser, in Mead, Washington; Alcoa, in Vancouver, and Wenatchee, Washington; Intalco, in Ferndale, Washington; Anaconda, in Columbia Falls, Montana; and Martin Marietta in The Dalles and Goldendale, Oregon.

With relief from the drought assured and aluminum production resuming, the cost of electric power will rise. The Pacific Northwest Power Supply and Conservation Act (HR 9020), supported by the industry as being the most equitable way to meet future energy needs, will triple the industry's power costs.

While the Northwest resumes aluminum production, Alcoa's two potlines at the Point Comfort, Texas, plant will be shutdown for an indefinite period. About 50,000 tons of aluminum output per year will be lost after April first because of the high costs of natural gas used to generate the plant's electricity. The alumina refinery at Point Comfort will continue to operate as will Alcoa's largest aluminum plant at Rockdale, Texas, which is powered by lignite-fueled generators.

In Sheffield, Alabama, Reynolds Metals Company will expand its secondary smelter to 100,000 tons per year.

Arsenic

(2) With completion of tests by the EPA in February, 1978, on the health effects of arsenic, cooperation of three other federal agencies, OSHA, FDA, and CPSC will be sought for scrutiny of potential health hazards and risk assessment of toxic substances, including arsenic. The EPA will propose reduction of arsenic emissions, while OSHA will order controls and respirators for exposure.

Copper

(3) Negotiations with interested companies by the Colville Confederated Tribes will begin immediately concerning the development of a large, open-pit

copper mine which would become the second largest operation of its kind in the U.S. This massive copper-molybdenum open-pit mine will be located near the town of Keller, Washington.

(4) The State Hearing Examiner of Wisconsin has dismissed a request of the Flambeau Mining Company (a Kennecott subsidiary) for permits to mine copper deposits in Grant (Rush County), Wisconsin. Too long a delay in making requested changes in the permit applications was given as the reason for denial. Kennecott must reapply if it wishes to pursue this operation further.

(5) Asarco's Tacoma, Washington, copper smelter can continue to operate at variance with air pollution standards in the state, as the Pierce County Supreme Court has ruled against the Washington State Pollution Control Hearings Board. The Washington Air Quality Coalition, an environmental group, plans an appeal.

Kennecott has also won a round in smelter emission rulings in New Mexico. The Environmental Improvement Board refused to classify the area surrounding Kennecott's smelter at Hurley, New Mexico as a nonattainment area (an area failing to meet standards emissions) because of work done in 1977 to control sulfur dioxide emissions. The board was told that there was no better control technology available to Kennecott than that which it already has in use.

The Environment Improvement Agency has prepared a map of Arizona showing nonattainment areas for particulate matter as Phoenix, Tucson, Hayden, Douglas, Ajo, and Globe and for sulfur dioxide as Ajo, Douglas, San Manuel, Hayden, Globe, and Morenci.

(6) Mining, concentration, and leaching operations, by Inspiration Consolidated Copper Company in Arizona, will be resumed by mid-January. The company had not reopened after the July-August strike of last year because of the depressed market. The Christmas mine and dump leaching at Inspiration, and mining operations at the Ox Hide mine will remain closed.

Outside consultants, together with executives of the Hecla Mining Company, are searching for a solution to the huge deficit acquired in the operation of the Lakeshore Mine near Casa Grande, Arizona. Maintenance expense was running $600,000 per month with total operational losses of $30 million in about 20 months, when it was closed in August, 1977. The mine has estimated reserves of 500 million to 1 billion tons.

(7) Anaconda was reported to have curtailed operations at its copper mine near Yerington, Nevada, by 40 percent on December 31, 1977, with the discontinuance of processing sulfide ores. The oxide ores will be depleted by mid-1978 at which time the mine will close unless there is a market upturn.

Anaconda also continues to have regulatory problems with its smelter at Anaconda, Montana, and will pay a fine to avoid litigation even though they deny any air standards violation. They also have agreed to fund a study of the upper air in the vicinity of the smelter.

Anaconda is studying the economic feasibility of operating its underground mines at Butte, Montana, based on a new engineering procedure. The answer is expected by spring.

(8) The annual meeting of the Arizona conference of the A.I.M.E. was held in December, 1977. Several highlights of the papers given at this meeting follow:

The environmental effects of mining can be beneficial, as several mining companies have reclaimed areas that are more useful now than prior to mining.

The expansion program of Cyprus Bagdad's open-pit mine at Bagdad, Arizona, completed in 1977, resulted in employment increase of 50 percent, although ore production jumped 700 percent. The increased productivity resulted from the use of new and larger equipment.

The results of a study by the Morenci branch of Phelps Dodge, on the Concentrator Process Control System, indicate economic benefits from process control of a 9-ton per day increase in total copper production, a 10-ton per day increase in tonnage milled per man shift, and a 0.01 pound per ton decrease in froth reagent consumption. Another benefit is stabilization of the process which will probably decrease the likelihood of upsets.

The Magma Copper Company of Arizona has recently converted to the use of Nonel Primadets for blast initiation in its Superior mine. Significant improvements are fewer holes required, improved fragmentation, faster loading, and elimination of lost production from unfired holes. The Nonel system has proved to be more efficient and economical despite higher unit cost.

Sherritt-Cominco has developed a hydrometallurgical process to refine copper from sulfide concentrate which is applicable to a wide range of concentrate and recovers sulfur in the elemental form. Thermal activation with hydrogen decomposes chalcopyrites and pyrites into simpler sulfides, which, after iron removal, are leached under oxygen pressure to produce copper sulfate solution and elemental sulfur. The copper is recovered by electrowinning.

(9) President Carter has appointed a cabinet-level committee to study America's nonfuel mineral policies. Interior Secretary Andrus and Frank Press, Director of the Office of Science and Technology Policies, are to develop the framework of a top-level minerals study. Environment concerns will be a major part of the study, especially where a conflict exists between mineral development and land, water, or air pollution. Existing laws and regulations governing the nonfuel minerals will also be considered as part of this 15-month study.

The President has indicated his agreement of the concept of stockpiling copper, and it was predicted by Arizona Congressman Udall that a copper stockpiling bill would be introduced in Congress in January or February to alleviate pressures on the copper industry.

The debate continues on the Administration-sponsored Bill HR 9292 vs. the Ruppe Bill HR 5831 supported by the mines. The first field hearings were held in Phoenix in December, with the second scheduled for Grand Junction, Colorado, in February. Amendments to the Ruppe bill, which retains the most important features of the 1872 laws, will provide additional environmental protection as well as protection for individuals who own the surface but not the minerals on their land.

Other government actions (state and federal) that seek to alleviate the problems of the copper industry are (1) an increase in the current tariff for copper imports from eight-tenths to $0.07 a pound for the countries with Most Favored Nation status; (2) an equilization tariff of $0.10 a pound to assure that foreign competitors do not secure unfair competitive advantage over U.S. concerns by ignoring environmental considerations that domestic enterprises are required to observe; (3) relief from subsidized imports by an ad valorem tariff; and (4) state relief from the sales tax which taxes every pound of copper, and only copper, which is shipped from the State of Arizona.

(10) A recent newsitem of interest reported that the combined San Manuel and Superior, Arizona, operations of Newmont's Magma Copper Company in 1976 produced 363 thousand tons of sulfuric acid. Also produced were 186 thousand tons of refined copper, 2,000 tons of molybdenum concentrate, and significant amounts of gold, silver, selenium, and rhenium. The total direct contributions to the economy in terms of payroll and benefits, local purchases, and state and federal taxes was about $172 million. In 1977, the 300 millionth ton of ore was hoisted from the San Manuel mine, a new record for underground copper mines. About two-thirds of this orebody remains for future production. The San Manuel operation alone employs about 4,000 persons.

Lead

(11) The zinc fuming plant of the Bunker Hill Company's Kellogg, Idaho, lead smelter is temporarily suspending operations. The EPA has recently filed a suit in the amount of $25,000 a day against Bunker Hill for excessive particulate emissions. However, the company denies this to be the reason for the closing, stating depressed domestic markets due to excessive imports as the cause.

The EPA's proposed new standard for lead, a monthly average of 1.5 micrograms per cubic meter of ambient air by 1982, is causing much alarm and discussion among those affected. The situation may not be as bleak for copper and primary lead smelters as for the battery makers. -- Samples taken at Asarco's lead smelters at East Helena, Montana, and El Paso, Texas, never exceeded 1.8 micrograms, while those taken at Bunker Hill in Kellogg, Idaho, averaged 12.5 micrograms. Lead emissions from Anaconda's copper smelter at Anaconda, Montana, never exceeded 0.6 microgram. -- The main problem in battery manufacture or lead recovery is not stack emissions but fugitive emissions--dust from plant operations that require hoods, ducts, and fans to remove the dust through a filter system. Also, these plants are usually located in urban areas where pollution is difficult to control, compared to the primary smelters which are located in sparsely settled regions. An investment of 32 percent of the secondary smelters' annual income could be required to meet the standards advocated by the EPA, a hypothetical case points out.

A very thorough study of heavy metal body burdens of persons residing near nonferrous smelters in Ajo, Arizona, is being carried out by the Arizona Department of Health and the Research Triangle Institute. Three hundred twenty persons, ages 1 through 60 plus, are involved in blood, hair, and urine sampling. Drinking water, dust, and soil samples are also being collected. Although specific results have not been announced, no significant health problems have been identified in the physical examinations and lab studies, to date.

Magnesium

(12) The Utah magnesium plant of NL Industries, Inc., has recently undergone modification and its capacity of 24,000 tons per year was expected to be reached by the end of 1977.

Molybdenum

(13) With the acquisition of Molycorp by Union Oil, an agreement has been reached with Kennecott whereby Kennecott has terminated its joint-venture interest with Molycorp in the development of a molybdenum property for a new underground mine near Molycorp's Questa, New Mexico, operations. The Union Oil/Molycorp plans for the new operation are in early stages, and no sizing decisions have yet been made.

(14) Phelps Dodge Corporation has announced discovery of a deposit of porphyry-type molybdenum mineralization with minor tungsten values near Milford, Utah, in Beaver County. In four drill holes, mineralization was located 3000 to 5000 feet beneath the surface and was 200 to 950 or more feet thick and assayed 0.29 to 0.38 percent molybdenum disulfide. An extensive drilling program and economic feasibility studies, taking several years, must be undertaken before mining can begin.

(15) At Quartz Hill, 45 miles east of Ketchikan, Alaska, the U.S. Borax and Chemical Corporation has found a potential molybdenum orebody in excess of 250 million tons at or near the surface which can be mined by the open-pit method. The ore assays 0.18 to 0.25 percent molybdenum disulfide, with 50 million tons of 0.25 percent ore outcropping at the surface. Permission to construct an access road is being delayed because of an appeal by environmental groups with the U.S. Forest Service. Development of the project will depend on successful resolution of the access road issue.

Nickel

(16) The Port Nickel refinery of Amax Nickel, Inc., will not increase nickel production to capacity but will operate at 75 percent capacity during the first half of 1978 because of excessive nickel inventories. This will amount to about 50 million pounds of nickel and 750,000 pounds of cobalt.

To adjust its nickel inventories, Hanna Mining Company's Riddle, Oregon, mine and smelter operations were suspended for 6 weeks during January and February.

Precious Metals

(17) Predictions that gold may be selling at $190 to $200 per ounce by the end of 1978 have resulted in an increase in exploration and development activities. The following are some of the latest to be announced:

A placer mill has been constructed by the A. J. Madden Company near Quartzsite, Arizona, to extract gold from gravel originating in the nearby Plomosa Mining District. Production will reach 1000 yards per 16-hour day in a few months.

Mining is to be reinstituted this spring at the Mary Nevin mine near Cripple Creek, Colorado. A significant orebody was found at 300 feet in the old mine, first staked in 1895 and last operated during World War II.

The Duval Mining Corporation has plans to invest $4.5 million to convert its Battle Mountain, Nevada, copper operation to gold mining. The work is to begin in March and be completed late this year.

The Jarbidge Wilderness area of Nevada is the subject of a USGS mineral resources report recently published. More than $10 million worth of gold and silver production was recorded between 1910 and 1949 from the Jarbidge Mining District in this area.

(18) The San Juan Milling Company has spent nearly a million dollars on exploratory drilling on the Henrietta mine at Silverton, Colorado. Appreciable quantities of silver, copper, lead, and zinc have been found. Assays as high as 15 ounces of silver per ton, 10 percent lead, 15 percent zinc, and 0.5 percent copper have been obtained.

Tungsten

(19) Teledyne Wah Chang's Strawberry mine near Yosemite National Park in California recently has begun production and will produce about 800,000 pounds of tungsten in 1978, making it the fourth largest tungsten mine in the U.S.

Vanadium

(20) Union Carbide will suspend operation at its mine and mill near Hot Springs, Arkansas, early this year. This complex accounts for the largest domestic output of vanadium oxide in the U.S. and should be able to resume operations in 6 to 12 months after market conditions have improved and inventories have become lower.

Zinc

(21) Closure of the Eagle, Colorado, zinc mine has been announced by the New Jersey Zinc Company because of high costs, low prices, and depleted reserves.

(22) Eagle-Picher Company's Shullsburg and Bear Hole operations in southwestern Wisconsin may be forced to close in 2 years or less because of excessive zinc discharge from minewaters into ground water. Conformance to the EPA's standard of 0.75 mg per liter to be invoked on January 1, 1980, is not economically feasible. The current allowable of 3.5 mg per liter can be met.

(23) Operations were planned to be suspended by February 15, 1978, at the Ontario mine near Park City, Utah. A joint venture of Anaconda and Asarco (Park City Ventures), Park City, conducted lead, zinc, and silver mining and milling operations. Operating problems relating to rock conditions and ground water resulted in high costs, making the operation unprofitable.

(24) In the lone bright spot concerning the future of domestic zinc, production of the Elmwood, Tennessee, mine of the Jersey Miniere Zinc Company has recently been increased to 3000 tons per day and in August of this year, another mine at Gordonsville, Tennessee, (3 miles from the Elmwood mine) will begin production at 9000 tons per day. Another mine site is being explored for zinc,25 miles from these two mines.

Miscellaneous

(25) Superior Oil of Houston and Louisiana Land and Exploration have reported significant deposits of zinc and copper and small amounts of silver and gold in northern Maine. These exploratory drill holes show 9 percent zinc, 4 percent copper, 2.57 ounces of silver, and 0.04 ounces of gold per ton.

Sea Nodules

(26) A study of the environmental, social, and economic effects of the sea nodule processing facilities in the Hawaiian Islands is tied to a companion NOAA study of the effects in the ocean proper (see Technology and

Trends 15.1.4, page 1). Federal and state funding from DPED and NOAA totals $200,000 to date.

AIME Meeting

(27) The Annual Meeting of the American Institute of Mining, Metallurgical, and Petroleum Engineers held in Denver, February 26-March 2, 1978, featured more than 200 split-day sessions, at which more than 1000 papers, talks, panel discussions, and seminars were presented. Of particular interest were several All-Institute sessions to consider and discuss general societal, environmental, economic, and regulatory issues impacting the minerals industry. At these sessions, considerable concern was expressed over future availability and economics of energy, although some participants expressed confidence in man's ability to adapt to whatever the future might bring. A common lament by attendees from industry was the terrific and ever-increasing burden placed on industry by various government regulations. Selected papers dealing with technology in the nonferrous metals industry will be reviewed in the next issue of the USEPA Awareness Bulletin.

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American Metal Market, 86 (4), 1, 9 (January 6, 1978).

(2) Chemical Week, 122 (2), 18 (January 11, 1978).

(3) The Mining Record, 89 (3), 1 (January 18, 1978).

(4) U.S. Bureau of Mines, Minerals and Materials, 49 (January, 1978).

(5) Mining Journal, 290 (7433), 87 (February 3, 1978).
New Mexico Paydirt, (9), 28 (February, 1978).
Arizona Paydirt, (463), 13 (January, 1978).

(6) Engineering Mining Journal, 179 (1), 133 (January, 1978).

(7) Mining Engineering, 30 (1), 17 (January, 1978).
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(8) Skilling's Mining Review, 67 (2), 1, 6, 7, 14-19 (January 14, 1978).

(9) Arizona Paydirt, (463), 20, 22 (January, 1978).
Arizona Paydirt, (462), 14, 16 (December, 1977).
New Mexico Paydirt, (8), 8, 10, 12 (January, 1978).
New Mexico Paydirt, (9), 20, 23, 24 (February, 1978).

(10) New Mexico Paydirt, (8), 3 (January, 1978).

(11) Mining Journal, 290 (7433), 87 (February 3, 1978).
Skilling's Mining Review, 67 (5), 27 (February 4, 1978).
Environmental News, U.S. EPA, R-289, 1-4 (December 12, 1977).
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Arizona Paydirt, (462), 54 (December, 1977).

(12) U.S. Bureau of Mines, Minerals and Materials, 9 (December, 1977).

(13) New Mexico Paydirt, (8), 6 (January, 1978).

(14) The Mining Record, 89 (2), 1 (January 11, 1978).
Arizona Paydirt, (463), 16 (January, 1978).

(15) American Metal Market, 86 (27), 12 (February 8, 1978).
The Mining Record, 89 (3), 1 (January 18, 1978).

(16) Mining Congress Journal, 63 (12), 7 (December, 1977).
U.S. Bureau of Mines, Minerals and Materials, 4, 5, 9 (December, 1977).

(17) The Mining Record, 89 (6), 1, 10, 23 (February 8, 1978).

(18) The Mining Record, 89 (6), 4 (February 8, 1978).

(19) American Metal Market, Tungsten Section, 86 (3), 8-9 (January 5, 1978).

(20) U.S. Bureau of Mines, Minerals and Materials, 47 (December, 1977).

(21) U.S. Bureau of Mines, Minerals and Materials, 5 (January, 1978).

(22) Engineering Mining Journal, 179 (1), 137 (January, 1978).

(23) Skilling's Mining Review, 67 (4), 4 (January 28, 1978).

(24) U.S. Bureau of Mines, Minerals and Materials, 52 (December, 1977).

(25) U.S. Bureau of Mines, Minerals and Materials, 49 (December, 1977).

(26) U.S. Bureau of Mines, Minerals and Materials, 48 (December, 1977).

(27) Annual Meeting of AIME, Denver, Colorado, January 26-March 2, 1978.

RECENT PATENTS

4,065,110
METHOD AND APPARATUS FOR PURIFYING BLISTER FURNACE EFFLUENT
Ralph A. Koenig, assignor to John Zink Company, Tulsa, Oklahoma

(A mechanical arrangement for treating gaseous discharge from blister copper refining furnaces is claimed. Stages include particulate settling, precooling, oxidation, and cooling and waste-heat recovery before passing to baghouse and stack.)

4,065,300
METHOD FOR EXTRACTION OF COPPER PRODUCTS FROM COPPER BEARING MATERIAL
Archie L. Poarch, Mesa, Arizona

(Claims a hydrometallurgical process for purification of cement copper involving nitric acid dissolution, NH_3 complexing and reduction, conversion to cuprous oxide, redissolution in nitric acid, and disproportionation to pure copper and cupric nitrate (recirculated). Impurities are rejected during first-stage ammonia neutralization. Ammonium nitrate is a by-product.)

4,066,445
PROCESS FOR PRODUCING MAGNESIUM UTILIZING ALUMINUM METAL REDUCTANT
James D. Johnston, Robert N. Sanders, and James M. Wood, Jr., assignors to Ethyl Corporation, Richmond, Virginia

(An aluminothermic method for magnesium production from MgO is claimed. Temperatures of about 1600 C are required.)

4,066,520
SLURRY ELECTROWINNING PROCESS
Robert C. Emmett, Jr., James K. Dicksa, Bruce C. Wojcik, and Frank A. Baczek, assignors to Envirotech Corporation, Menlo Park, California

(Calcium sulfite treatment of pregnant copper leach liquors precipitates pure copper values for subsequent electrowinning.)

4,066,733
METAL EXTRACTION FROM SEA NODULES
Michael Dubeck and Gordon G. Knapp, assignors to Ethyl Corporation, Richmond, Virginia

(Ammoniacal leaching of nickel, copper, and cobalt from sea nodules is improved by preroasting at 400 C maximum in gases from alcohols and aldehydes. Improved cobalt solubilization is claimed by sulfite additions to the leachant.)

4,067,952
LEACHING OF COPPER-NICKEL CONCENTRATES
Willem H. Pittie and Kingsley F. Doig, assignors to Anglo-Transvaal Consolidated Investment Company Limited, Johannesburg, South Africa

(Claims a multistage, combined hydrometallurgical and roasting process for separating nickel and copper values from a nickel-copper sulfide matte.

Part of the nickel is recovered in a first leach with HCl. Residue is sulfate-roasted, water leached, treated with H_2S to precipitate CuS. Remaining nickel is hydrometallurgically purified, converted back to the chloride, and electrowon.)

4,069,119
COPPER RECOVERY BY LEACHING AND ION EXCHANGE
Soon Y. Wong, assignor to Continental Oil Company, Ponca City, Oklahoma

(Claims a two-stage solid ion exchange-elutriation process combined with electrowinning for the hydrometallurgical recovery of copper from ore.)

4,069,294
HYDROMETALLURGICAL RECOVERY OF METAL VALUES
Laurence G. Stevens, assignor to UOP, Inc., Des Plaines, Illinois

(Hydroprocessing of sea nodules incorporating a prereducing roast in HCl (halide) to facilitate recovery in subsequent ammoniacal leaching. The novel feature appears to be the method of recycling the HCl.)

4,069,296
PROCESS FOR THE EXTRACTION OF ALUMINUM FROM ALUMINUM ORES
Wen H. Huang, Texas A & M University, College Station, Texas

(Recovers and purifies aluminum values from ore using HF leaching-complexing and hydrometallurgical purification of the leachate resulting in a hydrated aluminum hydroxide product.)

4,070,182
RECOVERY OF PRECIOUS METALS FROM METAL SULPHIDES
Roman M. Genik-Sas-Berezowsky, Verner B. Sefton, and Lynton S. Gormely, assignors to Sherritt Gordon Mines Limited, Toronto, Canada

(Features $(NH_4)_2S_2O_3$ treatment of copper sulfide ores, or leach residues from these, to recover gold in soluble form.)

4,070,183
METHODS OF SEPARATING AND RECOVERING COPPER FROM MATERIALS CONTAINING COPPER
Alan James Parker and David Michael Muir, assignors to Anumin Pty. Ltd., Canberra, Australia

(A method for recovering copper from ores involves treating an impure, pregnant leach liquor with sulfite to precipitate copper sulfite, separating this, redissolving the sulfite in acetonitrile or 2-hydroxycyanoethane water to yield cuprous sulfate, then disproportionating the cuprous salt to metallic copper and cupric sulfate for recycle.)

4,070,260
PROCESS OF SULFURIC ACID LEACHING SILICATED ZINC ORES
Noel Dreulle, assignor to Compagnie Royale Asturienne des Mines, Brussels, Belgium

(A hydroprocess for zinc from siliceous ores. The silica gel problem is overcome by evaporation of 60 percent of the water to crystallize the silica, thence resolutioning to allow removal of the Zn SO_4.)

4,071,278
LEACHING METHODS AND APPARATUS
Neil L. Carpenter, Kerrville, Texas, and Clark Goodman, Coronado, California

(This claims a process and apparatus for electrolytic-assisted leaching of ore bodies *in situ*.)

4,071,611
CONTINUOUSLY LEACHING AN ORE COLUMN
Richard E. Chilson, Tucson, Arizona

(A mechanohydraulic scheme and apparatus for continuous vat leaching of ore, with built-in washing of the residue.)

4,072,503
THERMAL TREATMENT OF LEACHING RESIDUE FROM HYDROMETALLURGICAL ZINC PRODUCTION
Stig Arvid Petterson, Tor Lindstad, Frøystein Dyvik, and Georg Steintveit, assignors to Det Norske Zinkkompani A/S, Odda, Norway

(For residues from a hydroprocess for zinc (containing lead and residual zinc); this is a combination controlled oxidation-reduction roasting process to recover and separate metallic lead and zinc values.)

4,072,504
METHOD OF PRODUCING METAL FROM METAL OXIDES
Örn Gunnar Perdahl and Sven Oscar Santen, assignors to Aktiebolaget Svenska Kullagerfabriken, Goteborg, Sweden

(The claimed process for producing metals from oxides of tungsten, chromium, manganese, nickel, and/or iron combines direct reduction and an "inverse blast furnace" process. A shaft furnace is charged with a solid reductant (e.g., coke), and the prereduced (at least "33 percent reduced") oxides are blown through tuyeres into the reductant bed where reduction is completed. Molten metal accumulates on the hearth. Offgas is used for prereduction.)

4,072,507
PRODUCTION OF BLISTER COPPER IN A ROTARY FURNACE FROM CALCINED COPPER-IRON CONCENTRATES
Harold P. Rajcevic, William R. Opie, and Dominic C. Cusanelli, assignors to Amax, Inc., Greenwich, Connecticut

(Rotary-furnace smelting of dead-roasted copper ores is claimed. The furnace charge is the dead-roasted concentrate ($CuO + Fe_2O_3$ + some gangue), a particulate reductant sufficient to reduce CuO to copper and Fe_2O_3 to FeO, and SiO_2 sufficient to flux the FeO at an Fe·SiO_2 ratio of 1.2:1 to 4:1. The loaded rotary furnace, resembling a converter, is heated by an oxyfuel lance to the smelting temperature, where blister copper and slag is formed.)

FOREIGN TECHNOLOGY

(The articles listed are from foreign-language journals, with titles and abstracts printed in English.)

J. Czernecki, Z. Smieszek, and S. Sobierajski: "Thermodynamic Analysis of Lead Elimination from Copper in a Fluidized Bed (sic) Process"
Rudy Metale, 22 (11) (1977), 583-595 (Polish)

In calculations of selective lead oxidation from copper-bearing material (concentrates?) in what appear to be shaft furnace operations at refining temperatures from 1280 to 1380 C, the lowering of the metallic lead content to less than 0.2 percent requires that the oxygen content of the resulting copper would be in the range of 0.52 to 1.2 percent, expressed as dioxide (?). It appears that experimental results supported the calculations.

B. Czajka, J. Borkowski, and M. Szczap: "Technology of Xanthation in the Flotation Process of Lead Minerals"
Rudy Metale, 22 (11) (1977), 595-598 (Polish)

For a particular lead-zinc ore containing oxidized lead minerals, xanthation parameters were developed to optimize the selective flotation collection of lead minerals while suppressing zinc collection.

M. Oktawiec, T. Izdebska, and T. Grabowski: "The Role of the Institute of Non-Ferrous Metals in Studies on Flotation Agents"
Rudy Metale, 22 (11) (1977) 625-627 (Polish)

Research on collecting agents for flotation of copper and lead-zinc ores, including pilot trials, is described.

W. Pajak: "The Actual State and Prospects for a Thermal Enrichment Process of Zinc-Lead Materials"
Rudy Metale, 22 (11) (1977) 627-633 (Polish)

Present use of the Waelz process in Poland is described. Emphasis is on process adaptation for improved economy; substituting less expensive reductants for coke breeze is cited as one example. Discussion of Waelz-kiln treatment to upgrade low-grade zinc-lead ores and to recover values from zinc and lead-plant wastes is presented.

T. Kozubowski: "Zinc Strip Manufacutre Straight from Molten Metal"
Rudy Metale, 22 (11) (1977) 636-638 (Polish)

A continuous zinc sheet casting installation in Poland is described. This comprises an induction melting (or holding) furnace, distributor, a roll stand for solidification to sheet blanks up to 43 inches wide x 1/4 to 3/8-inch thick, a roll leveler, a guillotine shear, and a roll coiler. This is designed to produce up to 10,000 tons per year.

M. Duczmal and J. Starosta: "Properties of Isolated Thionic Bacteria in the Area of the Legnica-Glogów Copper District"
Rudy Metale, 22 (12) (1977) 681-683 (Polish)

The capabilities of Th. thiooxidans, Th. ferrooxidans, and Th. thioparus for oxidizing Cu_2S were compared. Microbiological acidification and leaching of copper from regional ores were investigated.

G. Sokalaska, E. Doroszkiewicz, and P. Lelowski: "Leaching of Lead, Silver, and Copper by Alkaline Chloride Solutions"
Rudy Metale, 22 (12) (1977) 690-694 (Polish)

Residues from acid leaching of copper concentrate were further treated by leaching with salt (and other additions) at 80-90 C to extract residual copper, silver, and lead values. In 20 minutes, about half of the silver and copper and most (∿90 percent) of the residual lead were extracted. Silver recovery can be increased to about 80 percent by first treating the residue to remove the ferrous ions.

R. Bertram, M. Clement, N. Galitis, and H. Illi: "Leaching of Chalcopyrite with Adding Current"
Erzmetall, Vol. 30 (1977) No. 11, 491-496 (German)

Various particle-size fractions of chalcopyrite from the Mitterberg (Austria) ore deposit were leached anodically at various current-potential conditions. Feeder-anodes of coal, lead, and gold were investigated in especially developed packed-bed reactors at various H_2SO_4 concentrations. The results of the electrochemical process are discussed, and proposals for the further development of the research studies are made.

A. Yazawa: "Trends in Modern Copper Smelting Processes"
Erzmetall, Vol. 30 (1977) No. 11, 511-517 (German)

After discussing traditional copper smelting processes (reverberatory, electric or blast furnace), flash smelting is described, together with the experienced disadvantages. Various, newly proposed smelting processes are classified into four categories, and detailed critical evaluations are given for two promising processes, Noranda and Mitsubishi. Combining observations with the theoretical considerations, desirable conditions for a copper smelting process are summarized.

TECHNICAL AWARENESS BULLETIN - NONFERROUS METALS

This is a bimonthly publication of the USEPA's Metals and Inorganic Chemicals Branch, Office of Research and Development, designed to spotlight selected events and concerns of the nonferrous metals industry.

HIGHLIGHTS

- Third-quarter operating losses and facility closures reflect the continued depressed domestic copper market. Relief was denied by Congress in late action in 1977.
- Depressed zinc markets and prices effect further closures.
- The Federal Mine Safety and Health Amendments Act of 1977 puts new teeth in inspection operations and punitive possibilities by the government to ensure safe practices by operators of hardrock as well as coal mines.
- Ambient air lead limits intended to protect children's health are expected to be set by EPA at 1.5 $\mu g/m^3$ in June of 1978. Lead and copper smelters could be severely impacted, and some plant closures may result.
- Potential miners of sea nodules were dealt a blow by removal of indemnification provisions during recent markups of the Metcalf and Murphy-Breaux bills.
- A significant new domestic source of tungsten is the Tungsten Peak Mines operation by Graham and Associates near Ridgecrest, California. At capacity, concentrate production of 70-80 tpd will be shipped to Union Carbide for processing.
- Alcon's improved P-225 computer-controlled aluminum potline technology is being offered to industry.
- USEPA has issued a final ruling that exempts copper smelter's unusual emissions associated with startup, shutdown, or malfunction from violation of new-source air pollution standards.

Individually contributed news items may be submitted to Mr. Fred Craig, Metals and Inorganic Chemicals Branch, Industrial Environmental Research Laboratory, USEPA, 5555 Ridge Avenue, Cincinnati, Ohio 45268, 513-684-4491.

Prepared by Battelle's Columbus Laboratories under EPA Grant R805095.

NON-FERROUS METALS INDUSTRIES

IN THE NEWS

Aluminum

(1) The Mobile Alabama Works of Alcoa, which converts bauxite to alumina, plans to curtail production 25 percent because of drouth-induced power shortages at its smelting units in Alcoa, Tennessee, and Warrick, Indiana.

(2) Poor conditions in the industry, coupled with overcapacity, especially on the West Coast, has resulted in Apex International Alloys, Inc.'s closing its secondary aluminum smelting operation in Carson, California. "No great thought" has been given to a possible reopening of this plant; however, Apex is opening a new dross and salt recovery plant in Bicknell, Indiana, on January 1, 1978.

(3) The P-225 aluminum smelting technology developed by Alcoa is being offered to industry. The potline system with self-adjusting anodes, each under the control of a process computer, results in improved production efficiency, labor, and energy savings. Already in use at Alcoa's operations in Massena, New York, and Alcoa, Tennessee, the process affords the recovery of 99 percent of the fluorides generated in the smelting.

Antimony

(4) Asarco's $7 million facility for leaching antimony from copper-antimony-silver ore at its El Paso smelter has been completed. Capacity is 1200 tons of antimony per year. Concentrates come from the Coeur and Galena silver mines in Idaho.

Copper

(5) A study to be conducted by Environmental Research and Technology, Inc. will assess the effects that a copper-zinc underground mine will have in the area of Exxon Minerals' Penos Altos discovery in Grant County, New Mexico.

(6) Occidental Minerals Corporation (Oxymin), the owner of the Van Dyke copper deposit 1100 to 2000 feet beneath the town of Miami, Arizona, has, since 1968, been conducting an exploration program. In 1976, it was decided to begin in situ leach pilot testing of the approximately 100 million tons of 0.5 percent grade ore. Weak sulfuric acid injected into a hydrofractured zone of the ore body through two drill holes proved the feasibility of the method of recovering the copper. However, further testing and evaluation are

necessary to determine engineering data needed to economically justify proceeding with the development stage.

Two wells have been sunk to monitor the effects of the operation on ground water in the area and analytical data show that no significant change in chemical composition has occurred during the leaching activities. Although the deeds to the land above the deposit absolve Oxymin of any liabilities, the company has agreed to assume full responsibility for any damage to surface property caused by the underground mining.

(7) Kennecott's new Magna copper smelter near Salt Lake City, Utah, has just completed a $280 million project to control emissions. To save Kennecott some $10 million in interest payments and at no cost to the taxpayers, Salt Lake County commissioners are lending Kennecott the county's credit rating and issuing $70 million in tax exempt industrial revenue bonds with the guarantee that Kennecott will pay the debt.

(8) Continental Oil Co. has exchanged 3,066 acres of its land (and $353,742 cash) for 5,699 acres of state land northwest of Florence, Arizona. Conoco plans to use the state land for a mine dump, leaching pad, and ancillary services for its copper deposit near Florence. Questions of water rights must be resolved with the nearby Gila River Indian Reservation before development can proceed.

(9) To remain competitive in copper production, Kennecott's Ray mines in Arizona has recently acquired a 15-yard electric shovel and six 250-ton and one 120-ton trucks.

(10) A legal fight appears imminent between federal, state, and copper industry officials over legislation passed in the form of amendments to the national Clean Air Act. The aim of the amendments, passed in August, 1977, is to guarantee that by 1988 no sulfur dioxide is released into the air by copper smelters. Industry will be allowed to postpone for up to 10 years spending the large sums of money necessary to eliminate the smelter pollution, providing it does a better job now of reducing pollution with equipment currently in use, and providing it agrees in advance to pay the penalties.

(11) On October 7, 1977, President Carter lifted the government moratorium on copper stockpiling purchases, a move, it is felt, that will bolster the copper industry. However, on October 20, 1977, an amendment by Senator Domenici of New Mexico, that would have authorized federal purchases of copper for the depleted national stockpile, was defeated. Domenici's plan was for the government to sell some of its tin stockpile (tin is at a record high price) to purchase copper, but it failed because Domenici and Udall tried to "railroad" the bill through Congress without committee discussions and debate, a process that invoked the skepticism of too many senators.

(12) The Smelter Control Research Association (S.C.R.A.) has announced the results of a 2-year pilot investigation conducted at the Magma Copper Company in San Manuel, Arizona, on the removal of sulfur dioxide from copper reverberatory furnace gases. Differing from other double-alkali processes,

the S.C.R.A. process uses limestone for regeneration of scrubbing liquor. The precipitation of calcium salts which cause scaling and plugging are minimal, and are confined to the regeneration system.

(13) The crisis in the copper industry continues to make news. Anaconda has announced it will close its Arbiter hydrometallurgical refinery in Anaconda, Montana, on December 9, with the leaching and precipitating operation at Butte to be phased out over a 2-3 month period. Cities Service announced that it is terminating all nonhydrocarbon exploration. However, no change in plans for its operations at Copperhill, Tennessee, and Miami, Arizona, is anticipated. Ranchers Exploration and Development Corp. is curtailing mining operation at the Bluebird Mine near Miami, Arizona. This is the company's only significant copper operation. Huge losses highlighted the third quarter financial reports of Amax, Asarco, Cities Service, Cyprus, Hecla, Inspiration, Kennecott, Magma, and Phelps Dodge. The only somewhat brighter news was that Asarco would resume operations on a reduced basis at its Sacaton Unit near Casa Grande and its Mission and Silver Bell Units near Tucson, Arizona, and that Inspiration plans to resume some of its Arizona mining operations early in January, 1978.

Some market analysts appear hopeful that the copper market has bottomed out and the industry is now ready for a sustained, slow recovery with copper prices at about $0.70 a pound late in 1978. The industry, however, is not as optimistic, and capital spending projections show they will invest little more than that necessary to maintain mines and meet environmental standards for 1978.

(14) The EPA has ruled, in resolution of a court challenge, that emissions from copper smelters during periods of start-up, shutdown, and malfunction will not be considered a violation of new-source air pollution standards.

Lead

(15) A new concept developed by a Bunker Hill geologist for finding ore in the Coeur d'Alene Mining District, has been announced. Although still in the development stage, it has met with success at Bunker Hill. The criteria is based on the theory that folding or bending of the earth's crust causes breaks to occur in the rocks, and it is in these fractures that ore deposition takes place. Wasteful and costly drilling programs could be prevented in unfavorable areas if this concept proves to be acceptable.

(16) The 72 lead and copper smelters in the U.S. will be hit hardest by an EPA proposed standard that would limit concentrations of lead in the air by 1982 to 1.5 micrograms per cubic meter of air. The standards are expected to be issued in final form in June, 1978, with the states having 9 months to draft plans for meeting the EPA standards.

It is estimated that $600 million will be needed to clean up point source lead pollution. Necessary investments would be prohibitive for some smelters and would result in their closure. The expected standards have been forced by a court ruling that stems from increasing concern over high lead contents in the bloodstreams of children.

Molybdenum

(17) Processing of tungsten-molybdenum ore at Black Horse Mine, Nevada, was begun in September, 1977. Average grade was 0.19 percent tungsten and 0.65 percent molybdenum with 60 percent recovery. Recovery improvement to 85-90 percent is expected.

Precious Metals

(18) A vein of quartz-siderite containing significant quantities of silver-bearing tetrahedrite has been exposed in a crosscut driven at the Royal Apex property in the Two Mule area north of Auburn, Idaho. Sampling and diamond drilling is being planned.

(19) Exploration work began in May, 1977, and drilling will start in 1978 on 1872 acres of land recently acquired by Helena Silver Mines, Inc. in Montana.

Good progress has been made by Helena Silver at the Ruby Creek, Montana, placer gold operation with the installation of a suction dredge and related equipment. Production will begin in 1978 at the rate of 1000 yards per day.

(20) The richest gold deposits known in interior Alaska are those north of Fairbanks in the Chandalar District, recently acquired by Little Squaw Gold Mining Co. Its success depends on the availability of financing, which Little Squaw has not had since it began development work in 1973.

Tungsten

(21) Tungsten Peak Mines near Ridgecrest, California, has recently begun production of 40-50 tons of tungsten concentrate daily. This production capacity will be increased to 70-80 tons per day of 25-60 percent tungsten. The mine is complete, from extraction of the ore through the primary and secondary milling processes, with the concentrate being packaged in steel drums and shipped to the Union Carbide Corp. (Editor's Note: At capacity, about 75 tons per day, at 45 percent concentration, and assuming the scheelite contains approximately 20 percent tungsten, a production capacity of 5000 tons of tungsten per year is calculated. As an indication of the scale of this operation, 5000 tons per year tungsten production is nearly one-third of the domestic consumption.)

Zinc

(22) Mysterious illnesses in humans, deaths in animals, and sterility in gardens near the electrolytic zinc smelter in Bartlesville, Oklahoma, led to an investigation by the EPA. They reported excess metals in the soil and in the tissues of one calf that died. However, the USDA and the Oklahoma State Department of Health also made investigations. The State agency claims, to date, that no metals have been found in animals processed for food. The USDA has not yet released their report.

(23) On November 30, 1977, Asarco, Inc. closed its New Market zinc mining unit near Jefferson City, Tennessee, for an indefinite period. Last year the New Market unit produced 13,000 tons of zinc contained in concentrate, or 13 percent of Asarco's total mine production. Escalating production costs, plus continued depressed conditions in the zinc market, were given as reasons for the closing. The Young and Immel mines in the Knoxville area will continue to operate for the present time.

(24) The Gilman, Colorado, zinc mine, owned by the New Jersey Zinc Co., a Gulf and Western Industries, Inc. unit, will close on December 31, 1977. A 24 percent decline in the selling price of zinc, the high cost of labor, and depleted ore reserves are given as reasons for the closure.

Miscellaneous

(25) The Resource Conservation and Recovery Act, signed into law on October 21, 1976, contains a large number of guidelines, criteria, and regulations, many of which will have definite implications for the mineral industry, especially those governing the disposal of solid wastes.

The mining industry generates solid wastes, disposes of them in sites which could be classed as dumps, and some of these wastes could be classified as "hazardous". Sometime during 1978, guidelines, definitions, descriptions, etc. of the various aspects of waste disposal will be published by the EPA to clarify the issues.

At this time, the only thing known for certain is that the cost of mining and treatment of minerals will increase, thus increasing the consumer prices for mineral-based goods.

(26) The Federal Mine Safety and Health Amendments Act of 1977 was recently signed into law by President Carter. Under this law, federal inspectors will have greater power to close down mining operations; safety training becomes mandatory, and miners will be paid for accompanying federal officials on four annual mine inspections. Penalties may be assessed up to $10,000 per violation, plus $1,000 for each day a violation is not corrected. Companies are prohibited from taking punitive action against employees who file complaints or refuse to work under existing unsafe conditions.

(27) While House hearings continue over the controversial hardrock mining issue (HR-5831, the Ruppe Bill favored by American Mining Congress vs. Barton's HR-9292, the Administration's leasing version), Idaho's Senator McClure has introduced a Senate version that will (1) provide maximum non-exclusive access for exploration of public lands, (2) provide exclusive individual exploration rights by area assignment, (3) grant exclusive development rights to successful prospectors, and (4) guarantee tenure for mining ventures.

Sea Nodules

(28) The insurance provision was stricken from the Murphy-Breaux deep seabed mining bill.

This provision would have indemnified the United States mining firms who engaged in seabed mining under government permits, but whose rights might be overridden by an international agreement to which the United States might subsequently become a party. The bill is gutted as far as the mining industry is concerned, as financing cannot be obtained unless investment guarantees are written into law.

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(3) American Metal Market, 85 (219), 8 (November 10, 1977).

(4) Arizona Paydirt, (461), 59 (November, 1977).

(5) Skilling's Mining Review, 66 (49), 4 (December 3, 1977).
New Mexico Paydirt, (7), 12 (December, 1977).

(6) The Mining Record, 88 (48), 4 (November 30, 1977).
Mining Engineering, 29 (11), 13. 16 (November, 1977).
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New Mexico Paydirt, (6), 10, 13-14 (November, 1977).

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American Metal Market, 85 (212), 13 (November 1, 1977).

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(9) Engineering Mining Journal, 178 (11), 253 (November, 1977).

(10) Arizona Paydirt, (460), 22 (October, 1977).

(11) New Mexico Paydirt, (6), 20, 22-23 (November, 1977).
Arizona Paydirt, (460), 18 (October, 1977).

(12) Skilling's Mining Review, 66 (52), 18 (December 24, 1977).

(13) American Metal Market, 85 (229), 19, 24 (November 28, 1977).
American Metal Market, 85 (244), 31,40 (December 19, 1977).
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The Mining Record, 88 (49), 5 (December 7, 1977).

(14) American Metal Market, 85 (214), 10 (November 3, 1977).
The Mining Record, 88 (51), 3 (December 21, 1977).

(15) The Mining Record, 88 (46) 1 (November 17, 1977).

(16) The Wall Street Journal, LVIII (42), 2 (December 13, 1977).

(17) The Mining Record, 88 (46), 1 (November 16, 1977).

(18) The Mining Record, 88 (44), 3 (November 2, 1977).

(19) The Mining Record, 88 (47), 1 (November 23, 1977).

(20) The Mining Record, 88 (44), 1 (November 2, 1977).

(21) The Mining Record, 88 (44), 3 (November 2, 1977).

(22) U.S. Bureau of Mines, Minerals and Materials, November, 1977, p. 49.

(23) American Metal Market, 85 (229), 19 (November 28, 1977).
Skilling's Mining Review, 66 (49), 4 (December 3, 1977).
The Mining Record, 88 (48), 1 (November 30, 1977).

(24) The Wall Street Journal, LVIII (49), 14 (December 22, 1977).

(25) Mining Congress Journal, 63 (10), 26-30 (October, 1977).

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(27) New Mexico Paydirt, (6), 28-31 (November, 1977).
The Mining Record, 88 (45), 1 (November 9, 1977).

(28) American Metal Market, 85 (209), 12 (October 27, 1977).

RECENT PATENTS

4,054,446
PROCESS FOR THE REFINING OF A METAL SULFIDE MELT
Simo Antero Iivari Makipirtti, assignor to Outokumpu Oy, Outokumpu, Finland

(A process for refining molten copper sulfide by chlorine sparging, using sulfur additions as necessary to maintain Cu_2S stoichiometry. Common metallic impurities are preferrentially removed as volatile chlorides. Impurity condensation and collection systems not described in abstract.)

4,055,415
PROCESS FOR THE REMOVAL OF ALLOYING IMPURITIES IN A SLAG-COVERED COPPER REFINING BATH
Mihaly Stefan; Tibor Nagy, and Sandor Daroczi, assignors to Csepeli Femmu, Budapest, Csepel, Hungary

(This patent relates to slagging technology in producing fire-refined copper, principally of secondary origin. Artificial slags, or fluxes, and metallic reductants are apparently selected in view of impurities to be removed.)

4,056,261
RECOVERY OF GOLD AND SILVER FROM MINE-RUN DUMPS OR CRUSHED ORES USING A PORTABLE ION-EXCHANGE CARBON PLANT
Robert M. Darrah, California

(A mechanical arrangement for counterflow extraction of gold and silver values from an alkali-cyanide heap-leaching lixiviant with activated carbon. Quantitative extraction information not given in the abstract. Barren lixiviant is returned to the leaching cycle. Processing of the stripped precious metal values is not covered.)

4,057,422
ORE TREATMENT PROCESS
Rollan Swanson, Santa Monica, California

(Processing of complex, multimetal ores involving (1) conversion to sulfides of the highest oxidation states, (2) water leaching and cementation of water-soluble metal sulfide values, (3) dissolution of selected metal sulfides in molten alkali metal polysulfide followed by selective distillation, and (4) selective distillation of metal sulfides not soluble in (3).)

4,057,611
PROCESS FOR RECOVERING ALUMINUM FROM ALUNITE
Larry D. Jennings and Wayne W. Hazen, assignors to Southwire Company, Carrollton, Georgia; National Steel Corporation, Pittsburgh, Pennsylvania, and Earth Sciences, Inc., Golden, Colorado

(Alumite is processed by drying, water-leaching to remove sulfur and alkali metals, crushing and separation to two size fractions. The fines are caustic leached, and the partly loaded liquor is used to then leach the coarse fraction.$Al(OH)_3$ is then precipitated from the pregnant liquor. From the brief abstract, this appears to be an adaptation of Bayer processing to a specific alunite deposit.)

4,060,464
METHOD FOR EXTRACTING AND RECOVERING IRON AND NICKEL IN METALLIC FORM
Per Anders Herman Henningsson Fahlström, Thomas Konrad Miöen, and Gotthard E. Björling, Djursholm, assignors to Boliden Aktiebolag, Stockholm, Sweden

(Extraction of Fe and Ni values from sulfide ores by acid leaching in the presence of ferric ion. Bleed liquor is reoxidized to Fe^{+3} in anode compartment of electrolytic cell, and balance of pregnant liquor is electrolyzed in the cathode chamber to recover metallic Fe-Ni alloy containing at least 15 percent nickel. Depleted liquor is combined with reoxidized liquor fraction and recycled to leaching stage.)

4,061,492
METHOD OF ORE REDUCTION WITH AN ARC HEATER
Maurice G. Fey and Edna A. Dancy, assignors to Westinghouse Electric Corporation, Pittsburgh, Pennsylvania

(An apparatus for smelting/reduction of oxidic metal concentrates. The smelting/reducing atmosphere is provided and heated by passing carbonaceous feed through an electric arc into the smelting/reducing chamber. Reducing offgas flows through a prereducing chamber where concentrate is partly reacted in the solid state, and combustion of the reducing gas occurs. The offgas from this is recuperated to preheat the incoming carbonaceous material, cycloned, and vented.)

4,061,711
RECOVERY OF VANADIUM VALUES
Kenneth A. Morgan and Robert R. Frame, assignors to UOP, Inc., Des Plaines, Illinois

(Leaching of fully oxidized vanadium concentrates in ammoniacal medium at 1 to 14 M. NH_3, 50 to 300 C, and 1 to 200 atm. to form water-soluble ammonium vanadate, which is subsequently crystallized and decomposed at 250 to 600 C to yield a V_2O_5 product.)

4,061,712
RECOVERY OF VANADIUM VALUES
Kenneth A. Morgan, Hoffman Estates, Illinois, and Marilyn Miller, Tucson, Arizona, assignors to UOP, Inc., Des Plaines, Illinois

(A precursor to 4,061,711 above, this provides for caustic leaching of vanadium ores/concentrates followed by NH_3/CO_2 sparging at pH 6 to 7 to precipitate insoluble ammonium vanadate. Steam stripping allows recycle of leach liquor and NH_3 values.)

4,062,675

ORE TREATMENT INVOLVING A HALO-METALLIZATION PROCESS

Abraham A. Dor, assignor to The Hanna Mining Company, Cleveland, Ohio

(This claims the recovery of cobalt or nickel from ores by blending the ground and roasted ore with a halide, e.g., chloride, and a reducing agent, e.g., metallic iron, whereupon a portion of the nickel transfers from the gangue to plate out on the iron. The merits of this process are not well-illucidated in the brief patent abstract.)

FOREIGN TECHNOLOGY

The articles listed are from foreign-language journals. The English abstracts were taken directly from the Tables of Contents of the respective journals.

Barthel, G: Recovery of Copper From Mine and Smelter Water by Solvent Extraction
Tech. Mitt. Krupp, Werks-Ber. Vol. 35 (1977), No. 2, pp. 25-36

A review is given of the processes used in removing copper from highly diluted mine water and recirculated water from copper smelters. A comparison is made between solvent extracton, cementation, and ion exchange using solid resins. Various extraction reagents used in solvent extraction, typical test results from the operation of a semicommercial plant, and the removal of organic entrainment from raffinate and strip electrolyte are discussed.

R. Bortel: Flotation of the Polish Copper Ores
Erzmetall, Vol. 30 (1977) No. 9, 396-398

In particular consideration of the copper ore flotation, the development of the flotation processes of nonferrous ores in Poland is described. The mineralogical and petrographic composition of the copper ores in the district of Lubin (Legnica-Glogow) is discussed. After that, details are given on the physico-chemical properties of the ores and their floatability. Furthermore, the author describes the flotation results so far, the construction and the equipment of the new copper ore dressing plants.

P. Halbach, K. Koch, H. J. Renner, K. H. Ujma: Pyrometallurgical Processing of Manganese Nodules and Lateritic Nickel Ores Using Waste Materials as Reducing Agents
Erzmetall, Vol. 30 (1977) No. 10, 458-464

Ores like deep-sea manganese nodules and lateritic nickel ores are mixed with sewage sludge respectively with waste compost. These mixtures are agglomerated. During thermal reaction, poor reducing gases are formed which are suitable for a selective reduction. Metalized particles are formed. These have grain sizes being great enough for the following beneficiation. First results of some enrichment experiments are described.

H. J. Lange, K. Hein, D. Schab, B. Geidel: Anodic Secondary Reactions of Silver in the Electrolytic Refining of Copper
Erzmetall, Vol. 30 (1977) No. 9, 369-374

Contents of silver in anode copper are dissolved anodically from the β solid solution. In the electrolyte near the anode a reprecipitation takes place by secondary reactions with anode slime formation. The precipitation of silver in contact with Cu, Cu^+ ions, and Cu_2Se, as well as CuAgSe by model experiments with radiometric analysis after labelling the $CuSO_4$ electrolyte with the silver isotope Ag 110 m has been investigated. An extensive precipitation was observed. The results enable conclusions to be reached about the mechanism of reactions, reaction velocity, the form of bonding of silver in the electrolyte and on its deposition in the cathode copper.

K. L. Sandvik: The Oxidation in Basic Sulfide Pulps and the Effect of the Resulting Thiosulphates on the Flotation Properties of Some Sulfides
Erzmetall, Vol. 30 (1977) No. 9, 391-395

Thiosulphates in the tailings of selective sulfide flotation circuits are known as contaminants calling for a long treatment. In this article, the formation in the solution of thiosulphate, sulfite, and sulfide is investigated. The formation of thiosulphate proved to be dependent on the index of pH, the supply of oxygen, the temperature, the reaction time and on the grain size. The investigations included the feeding pulps of some Norwegian copper zinc-ore dressing plants. In the initial cycles of the Cu-flotations, thiosulphate was found within the range of 130 to 1120 mg/l. The results are particularly discussed concerning the recirculation of the process water.

TECHNICAL AWARENESS BULLETIN
NONFERROUS METALS
VOL. 3, NOVEMBER 16, 1977

This is a bimonthly publication of the U.S. EPA's Metals and Inorganic Chemicals Branch, Office of Research and Development, designed to spotlight selected events and concerns of the nonferrous metals industry.

HIGHLIGHTS

- Doldrums deepen for the battered and beleaguered copper industry as 15 producers announce cutbacks that have idled some 8000 workers in Arizona alone. Basic problem--foreign production to generate dollars to pay oil bills continues to feed the copper glut and prevent prices from reaching domestic industry support levels--compounded by the cost of domestic requirements for environmental control and the recent hike in labor rates.
- Morris Udall (Arizona) has "felt the heat"--withdraws his H.R. 5806 for leasing system for hard-rock mining--pledges support for the American Mining Congress/Ruppe location patent bill. Arizona Small Mine Operations are not placated; recall petitions continue to circulate.
- ASARCO fights to keep its Tacoma, Washington, copper smelter operational; applies for new 5-year variance from state pollution regs.
- Industry/EPA confrontation over arsenic emissions expected in 1978.
- The spectres of bauxite cartelization and energy costs continue to press for nonconventional aluminum technology. Georgia kaolin resources provide one avenue; Alcoa/DOE embark to investigate direct carbothermic reduction process.
- Continued market strength for tungsten, silver, and gold is encouraging further exploration and mine redevelopment activity.
- Test mining and processing of sea nodules is scheduled for 1978.
- Dialogue between Japanese and American consortia is directed toward revitalizing the domestic chromite industry, idled since the 1950s.

Individually contributed news items may be submitted to Mr. Fred Craig, Metals and Inorganic Chemicals Branch, Industrial Environmental Research Laboratory, U.S. EPA, 5555 Ridge Avenue, Cincinnati, Ohio 45268, (513) 684-4491.

Prepared by Battelle's Columbus Laboratories under EPA Grant R805095.

NON-FERROUS METALS INDUSTRIES

IN THE NEWS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

September-October, 1977

Aluminum

(1) Intalco and other Washington State aluminum smelters will continue to be impacted by energy shortages imposed by drouth in the Pacific Northwest, as Bonneville Power is necessarily curtailing energy supplies.

(2) ERDA and Alcoa have a joint program to develop a carbothermic aluminum smelting process instead of electricity as its energy source. Using low-grade ore such as clay and anorthosite, an aluminum-silicon alloy will be produced by direct reduction in a closed system. By-product CO gas will be collected as a fuel or feedstock value. The joint program is priced at about $5 million, and evaluation will require 5 to 7 years.

(3) It is now definite; the site of the projected 197,000 annual ton Alumax aluminum smelter (reported in the July bulletin) will be in Berkeley County, South Carolina, 20 miles north of Charleston. Initial construction is targeted for the fall of 1978, with 32 months to complete the project. Zero discharge of process water will be planned.

(4) Concern for the economic stability of foreign bauxite as an aluminum raw material continues to cause interest in nontraditional resources. Georgia kaolins, variously estimated as from 5 to 15 billion tons, with alumina contents from 30 to 40 percent, are adequate to support a substantial aluminum industry. Husted of Georgia Tech anticipates the development of an integrated aluminum-producing complex for the winning of aluminum from kaolin by the last decade of this century.

Copper

(5) A modified scrubber-cooler has been installed at Kennecott's Magna Utah, copper smelter. Used with the new Noranda type continuous smelting vessels, the modified scrubber can handle over 200,000 actual cubic feet of smelter gases per minute. Cleaned of particulate matter and cooled to 97 F, these gases are used in making sulfuric acid.

(6) The expected development of a major new copper operation by Quintana Minerals near Hillsboro, New Mexico, has been postponed indefinitely due to the depressed copper market.

(7) "There is plenty of copper today and there will be plenty of copper in the foreseeable future", states an article in "World Mining" for September, 1977. The USBM estimates the world's copper resources which would be economically produced with future technology advances at 1,600,000,000 tons. A table is given showing the projected increase in free-world copper mine production capacity from 1976 through 1980. An account of the known world copper deposits awaiting favorable conditons for development is also given.

(8) Asarco is reported to have applied for a second 5-year variance from state regulations to keep its Tacoma, Washington, copper smelter in operation. Decision is expected by the end of October.

(9) Backed by the Bureau of Indian Affairs, the proposed development of a new open-pit copper mine on the Papago Indian Reservation south of Casa Grande, Arizona, by the Vekol Copper Mining Company (a subsidiary of Newmont) is awaiting environmental approval by the Secretary of the Interior. An annual production of 33,150 tons of copper and 1,200,000 pounds of molybdenum in concentrates can be maintained from proven reserves of 105 million tons, assaying 0.55 percent copper and 0.09 percent molybdenum per ton. Estimated mine/mill development costs are $80 million. Waste removal to open the ore body would be about 62 million tons.

(10) A plant is being designed for annual recovery of 143,000 pounds of uranium oxide from the copper dump leach solution of the Kennecott Copper Corporation mine and mill at Bingham Canyon, Utah. A 6,700 gallon per minute counter-current resin ion exchange process, followed by solvent extraction, will be used.

(11) The mining law bill HR-5806, written by Representative Morris Udall of Arizona, which would have replaced the claim-patent system of 1872 for mining on public land with a leasing system, has been withdrawn by Rep. Udall. This bill was so very unpopular with all those concerned with the mining industry,but, in particular, smaller miners, that petitions are being circulated throughout his district seeking Rep. Udall's recall. Rep. Udall promises to work against a similar but tougher executive bill on a mineral-leasing system proposed by Secretary of the Interior, C. D. Andrus. Larger industry factions favor a bill drafted by the American Mining Congress, introduced into Congress by Rep. P. E. Ruppe of Michigan. This bill maintains the location patent system, provides for modified free access of prospectors and miners to public lands, but provides for a system of royalty payments and for the filing of a mining plan. The smaller miners want no change made in the 1872 mining law, particularly the payment of royalties.

(12) Because of the depressed prices in the copper market, coupled with the increasing costs in wages and benefits, as the result of the recent strike settlement, a large number of copper mines and plants have been closed or the number of employees drastically reduced, due to production cuts. Those companies affected include Anaconda, Anamax, Asarco, Cities Services, Cyprus Bruce, Cyprus Pima Mining, Duval, Hecla, Idarado, Inspiration Consolidated, Kennecott, Kerramerican,Magma, and Phelps Dodge. The areas hardest hit by these cutbacks are Arizona, where some 8,000 mine workers have been idled, New Mexico, Utah, Nevada, Colorado, and Maine.

(13) Anamax and Asarco, jointly, are constructing a primary crusher, conveyor, and a sampling plant, to develop the Eisenhower group of claims, near Asarco's Mission unit south of Tucson, Arizona. Production of large tonnages of copper ore is planned to begin in 1978.

(14) Idaho Copper and Gold Mines is reopening old copper workings in the St. Joe mining district, Shoshone County, Idaho, where high-grade copper has been mined. Rehabilitation of two old tunnels is planned, then consideration will be given to downward extension of surface veins.

(15) The EPA is charged to regulate toward lower arsenic emission levels from copper, lead, and zinc smelters by August, 1978. An environmentalist group (the Environmental Defense Fund) charges that the arsenic levels near smelters have been as high as 0.354 micrograms/cubic meter. Smelter owners claim the levels have been reduced as far as practicable and they will close rather than pay the estimated $111 million per year for additional pollution control required to meet a proposed OSHA standard should this be the basis for forthcoming regulation.

Lead

(16) To eliminate sulfur dioxide gases produced in roasting lead and copper-bearing materials, an 800-tons-per-day sulfuric acid plant will be built at ASARCO's El Paso, Texas, smelter. It is part of a previously noted $98 million modernization and air quality program to be completed by mid-1978.

Magnesium

(17) Northwest Alloys (a subsidiary of Alcoa) has recently completed a $100 million plant near Addy, Washington, for the production of 24,000 tons per year of refined magnesium metal from dolomite. Included in the cost of the plant was $20 million for pollution control equipment.

Molybdenum

(18) Amax Exploration has upped its estimate of the potential molybdenum deposit located near Crested Butte, Colorado. It is now believed the deposit contains 130 million tons of 0.4 percent molybdenum, a 40-million-ton increase over that previously announced. The deposit is near Amax's Henderson complex, recently dedicated, and in a line with the Climax mine near Leadville, Colorado.

(19) Production ceased on September 1, at Molycorp's Questa mine in New Mexico, due to rock and mud slides in June and July. About a year's supply is stockpiled at the Questa complex, and molybdenum production is continuing at a reduced rate. Ore reserves in the open-pit mine are nearing depletion, and Molycorp is evaluating another molybdenum deposit at the Questa site in a joint venture with Kennecott.

(20) Low-water temperatures at the Climax molybdenum complex inhibits conventional lime treatment of waste water to remove heavy metals. Pilot studies of the Swift Lectra Clear process--electrocoagulation/electroflotation--have been successful, and Climax is proceeding with the installation of a full-scale, 2000 gpm Lectra Clear plant for use in series with ion exchange to clean wastewaters prior to discharge from the Climax property. This innovation is a first for the metal-mining industry.

Precious Metals

(21) The Nancy Lee silver mine near Superior, Montana, is being prepared for reopening, with the construction of a 1260-foot shaft. Crosscuts will be driven from the bottom of this tunnel to locate ore last mined in April, 1971, when the mine was closed.

(22) The St. Elmo silver mine near the Coeur d'Alene mines in the silver belt of Idaho is preparing to reopen. Colson and associates will open and rehabilitate underground openings, map and sample the vein, prepare the property for production, and mine any commercial ore found.

(23) The Sunshine silver mine in Idaho has acquired 42 acres of land near the mine for its new tailings pond. Preparation of the property and construction of the pond will take 2 years to complete.

(24) The Alaska-Juneau gold mine, once the largest underground gold mine in the world, will be permanently sealed, thus squelching nostalgic fantasies that the low-grade ore might once again be worked at a profit. Work is beginning on a $400,000 contract to seal one of the mine's main tunnels for use as a municipal water reservoir.

(25) Lions Mines, Ltd., are beginning work on the Washington gold property, which preliminary studies indicate contains upwards of 700,000 tons of productive gold-bearing material in the two upper zones. This ore assayed as much as 1.664 oz gold per ton. Open-pit mining is contemplated. The concentrator will handle 200 tons per day.

(26) Volcanic Gold, Inc., has reported purchase of the Miller Mountain property in Broadwater County, Montana. Confererate Gulch, which drains this area, is one of the major gold placer mining districts in Montana, with the gold lodes localized at the heads of the streams drained by this gulch. Volcanic Gold, Inc., also has gold mining claims in Churchhill County, Nevada, which are being mapped and sampled.

Tungsten

(27) Activity on tungsten properties in Utah is increasing due to the advance in price. In Box Elder County, ores are being mined at the Sun Uranium property in the Newfoundland Range, the Blue Lady Mine near Park Valley, and on the Glory Vein near Yost. A mill in Montello, Nevada, concentrates the Sun Uranium and Glory Vein ores while Blue Lady ore is sold direct.

Three properties are operating in the Gold Hill area of Tooele County. Fraction Lode ore is concentrated in Ely, Nevada, while ore from the Star Dust and B Estelle properties is sold without upgrading.

Zinc

(28) The Bunker Hill Company's Pend Oreille operation at Metaline Falls, Washington, was shut down on September 1 for an indefinite period. This action was precipitated by the depressed zinc market conditions and the strike at the Kellogg facilities which consumes Pend Oreille's zinc concentrates.

(29) The Citrate process, developed by the USBM for scrubbing of SO_2 from power plant stack gases, will be tested at the St. Joe Minerals Corporation zinc smelter at Monaca, Pennsylvania. Attached to one of two 50-mw boilers which generate electricity for the smelter, the test period will begin by the fall of 1978. The SO_2 is absorbed by a water solution of sodium citrate and citric acid and, by the addition of hydrogen sulfide to the solution, solid elemental sulfur is obtained.

(30) Exxon is studying the feasibility of exploiting their Crandon, Wisconsin, zinc-copper prospect at a mine production rate of 10,000 tons per day. This equates to production of about 180,000 tons of zinc and 35,000 tons of copper per year. Initial capital costs would be about $300 million (probably based upon open-pit mining, which may not appeal to state authorities on environmental grounds). If Exxon proceeds with this, operations would come on-stream no earlier than 1985.

(31) Callahan Mining is developing a zinc-lead orebody at the Van Stone mine in Stevens County, Washington.

Miscellaneous

(32) Negotiations between seven of the largest chrome ore users in Japan, and the largest processor in the United States, could lead to reactivation of nearly 400 mines in the counties of Siskyou and Dee Norte in California and Josephine County, Oregon. Crescent City, California, is a potential site for the location of a chrome processing plant. (West coast chromite mines have been inoperative since the days of government-subsidized production in the 1950's.)

(33) Sea trials are being conducted prefatory to mining tests with an American-owned vessel designed to mine up to 1000 tons of manganese nodules per day from the sea floor. The deposit selected for test mining lies 1200 miles southwest of San Diego and contains manganese, nickel, copper, and cobalt, with lesser amounts of molybdenum, vanadium, zinc, and iron. Material from the prototype mining operation will be processed in Belgium. If the process proves economical, a full scale plant will be built in the U.S.

(34) A major lead-zinc-silver-cadmium find has been announced by General Crude Oil and Houston Oil and Minerals at the base of the western Brooks Mountain Range north of Katzebue, Alaska. No reliable estimate of tonnage or grade of mineralization can be made without additional drilling and tests. However, preliminary drilling has shown the following assays: lead 1.5-8.5, zinc 5.8-25.5, cadmium .02-.25 percent, and silver .08-5.32 ounces per ton.

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RECENT PATENTS

4,040,950

CONCENTRATION OF ORE BY FLOTATION WITH SOLUTIONS OF AQUEOUS DITHIOPHOSPHATES AND THIONOCARBAMATE AS COLLECTOR

Donald Edwin Zipperian, James Allen Jones, and Thomas Brian Buza, all of Tuscon, Arizona, assignors to American Cyanamid Company, Stamford, Connecticut.

(A flotation collector for copper sulfides wherein selected dialkyl dithiaphosphates are added to thionocarbonates used in aqueous flotation units is claimed. The recovery of copper values is thereby improved.)

4,044,094

TWO-STAGE FLUID BED REDUCTION OF MANGANESE NODULES

Herbert E. Barner, Westford; David S. Davies, Andover, both of Massachusetts; and Lester J. Szabo, Prince Edward Island, Canada, assignors to Kennecott Copper Corporation, New York, New York.

(This invention relates to drying and conditioning copper- and nickel-containing manganese (nodules) ore to reduce Mn_xOy to MnO and oxidize copper and nickel values prefatory to ammonium carbonate extraction of the copper and nickel values; i.e., a method for improved separation and recovery of copper and nickel from manganese in sea nodule ores.)

4,044,096

SULFURIC ACID LEACHING OF NICKELIFEROUS LATERITE

Paul B. Queneau, Golden, and Eddie C. Chou, Arvada, both of Colorado, assignors to AMAX, Inc., New York, New York.

(Claims pressurized leaching of 1^{+}% nickel laterite slurry (<1/3 solids) by H_2SO_4 at 260 to 290 C and 700 to 1000 psig, with agitation to return at least 95 percent of nickel to solution. Neutralization to pH 1.8 to 4.5 during flash-down precipitates iron and aluminum and gives a pregnant solution with Ni:(Fe + Al + Cr)>2:1 to facilitate downstream processing.)

4,045,215

METHOD OF REFINING MATTES CONTAINING NICKEL

Pierre Leroy, Saint-Germain-En-Laye; Jean Georges Morlet, Nevers; and Jean Saleil, Saint-Etienne, all of France, assignors to Creusot-Loire, Paris, France.

(Claims staged conversion of nickel mattes using a coaxial tuyere design to introduce oxidative gas diluent as blowing for sulfur removal progresses for more complete desulfurization; also for improved tuyere life. Offgas concentration profiles are not given; this technology could produce dilute offgas in later stages and might impact gaseous effluent management.)

4,045,216
DIRECT REDUCTION OF MOLYBDENUM OXIDE TO SUBSTANTIALLY METALLIC MOLYBDENUM
Harry W. Meyer, deceased, late of Weston, Connecticut, by Elizabeth Jane Meyer, executrix; Jerry D. Baker, Ann Arbor, Michigan; and William H. Ceckler, Orono, Maine, assignors to Amax, Inc., Greenwich, Connecticut.

(This patent claims gas-flow control and temperature control in a moving bed reactor to sequentially reduce MoO_3 pellets to MoO_2 (exothermic), thence to Mo (endothermic). The concept is apparently directed toward improved energy efficiency in production of metallic molybdenum without altering environmental circumstances.)

4,046,851
TWO STAGE SULFURIC ACID LEACHING OF SEA NODULES
Kohur Nagaraja Subramanian, Mississauga, and Gerald Vernon Glaum, Oakville, both of Canada, assignors to The International Nickel Company, Inc., New York, New York.

(Claims a two-stage (100 C/260 C), controlled pH, H_2SO_4 leaching process for recovering Ni, Co, and Cu values from sea nodules with a "reduced tendency for scale formation".)

4,047,934
BENEFICIATION OF THE NONFERROUS METAL VALUES OF OXIDE-CONTAINING MATERIALS
Leslie John Pollard, Lower Templestowe, and Donald Fergusson Stewart, Doncaster, both of Australia, assignors to ICI Australia Limited, Melbourne, Australia.

(Selective carbothermic reduction of iron oxide in a fused (alkali metal/alkaline earth metal) chloride bath at 750 to 1300 C to beneficiate "a non-ferrous metal oxide" is claimed.)

4,047,938
PROCESS FOR REFINING MOLTEN METAL
Andrew Geza Szekely, Yorktown Heights, New York, assignor to Union Carbide Corporation, New York, New York.

(Claims a turbo-injector for refining/cleaning gas for use in nonferrous metal refining. The object is to maximize the refining efficiency of injected gas. This mechanical device appears to have potential for decreasing the volume and increasing the concentration of offgases in nonferrous metal-refining operations.)

4,047,940
SEPARATION AND RECOVERY OF COPPER METAL FROM AMMONIACAL SOLUTIONS
Alkis S. Rappas, Arlington, and J. Paul Pemsler, Lexington, both of Massachusetts, assignors to Kennecott Copper Corporation, New York, New York.

(Claims a process for copper recovery from ammoniacal solutions involving (1) conversion to and precipitation of copper acetylide, (2) converting the acetylide to a cuprous-nitride solution, and (3) disproportionation to recoverable metallic copper and a recyclable cupric complex.)

4,049,438

NONFERROUS METAL RECOVERY FROM DEEP SEA NODULES

Ramamrithan Sridhar, Mississauga; John Stuart Warner, Oakville; and Malcolm Charles Evert Bell, Sudbury, all of Canada, assignors to The International Nickel Company, Inc., Delaware

(This appears to be a "brute-force" method for recovery of Ni, Co, Cu, and 170 values from sea nodules involving (1) selective reduction of the metal values, (2) smelting to generate Mn_xOy-rich slag, (3) oxygen converting the crude metal to remove additional manganese, and (4) converting the semi-refined metal regulus to sulfides to facilitate separation of metal values.)

4,049,444

PROCESS FOR TREATMENT OF LATERITIC ORES

Malcolm Charles Evert Bell, Sudbury, and Ramamritham Sridhar, Mississauga, both of Canada, assignors to The International Nickel Company, Inc., New York, New York.

(Claims moving hearth gaseous reduction of pelletized nickeliferous silicate laterites at 1295 to 1320 C to achieve >80 percent nickel recovery as ferro-nickel particles. The pelletizing process incorporates 1 to 12 percent by weight reducing agent, including at least 1 percent liquid hydrocarbon, along with an "alkali metal compound" or an "alkaline earth-metal compound" as a "reagent".)

4,049,445

METHOD FOR THERMAL TREATMENT OF NICKEL ORE

Horst Weigel, Cologne, Germany, and Anton Spitz, deceased, late of Cologne, Germany, by Barbara Wilhelmine Spitz nee Schürmann, legal representative, assignors to Klockner-Humboldt-Deutz Aktiengesellschaft, Germany.

(This patent covers thermal reduction of nickel laterite ore in a three-zone furnace to accomplish (1) preheating, (2) heating, and (3) reduction. The method of reducing/heating/preheating countercurrent gas flow appears to provide the unique feature of this patent.)

4,049,770

RECOVERY OF COPPER AND ZINC AS SULFIDES FROM COPPER-IRON SULFIDES

Godefridus Maria Swinkels, Rossland; Robert Arthur Furber, Edmonton; Edward Francis Godfrey Milner, Warfield; Roman Michael Genik-Sas-Berezowsky, Edmonton; and Charles Ray Kirby, Rossland, all of Canada, assignors to Sherritt Gordon Mines Limited, Toronto and Cominco Ltd., Vancouver, both of Canada.

(Claims hydrometallurgical processing to recover copper and zinc values from thermally activated iron-copper-zinc sulfide concentrate. Covers autogenous-pressure leaching, with a leachate containing 20 to 100 gpl copper and 5 to 35 gpl H_2SO_4. This precipitates CuS and dissolves Fe and Zn. Zn is recovered by reacting the leach liquor with H_2S to precipitate ZnS.)

4,049,771
EXTRACTION PROCESS FOR RECOVERY OF RHENIUM
L. Rita Quatrini and Martin B. MacInnis, both of Towanda, Pennsylvania, assignors to GTE Sylvania, Incorporated, Stamford, Connecticut.

(Liquid-liquid extraction of rhenium at <50 mg/ℓ from an aqueous Re:Mo solution at relative concentrations between 1:2000 and 1:3000 is covered. The organic rhenium extractant, a quaternary ammonium compound with an alkyl (8-10 C) compound and a mineral acid anion, is claimed. Extractant concentration is 0.05 to 0.1 percent by volume in a carrier comprising at least 50 volume percent benzene. Rhenium stripping is accomplished without substantial loss in extraction capacity, so the stripped extractant solution is recyclable.)

4,051,220
SODIUM SULFIDE LEACH PROCESS
Enzo L. Coltrinari, Arvada, Colorado, assignor to Equity Mining Corporation, Vancouver, Canada

(This patent covers leaching of Sb/As/Au/Cu/Ag containing sulfide concentrates with Na_2S. This dissolves Sb, As, and Au values, rejecting Cu and Ag sulfides. Oxy-sulfur compounds are further processed and refined. Gold is recovered by LIX.)

4,053,305
RECOVERY OF COPPER AND SILVER FROM SULFIDE CONCENTRATES
Gary A. Smyres, Sparks; Philip R. Haskett, Reno; Bernard J. Scheiner, Sparks; and Roald E. Lindstrom, Reno, all of Nevada, assignors to The United States of America as represented by the Secretary of the Interior, Washington, D.C.

(A process for recovering copper and silver from complex sulfide ores or concentrates containing copper, zinc, silver, lead, arsenic, antimony, and iron comprising (1) treating a slurry of the ore or concentrate in an aqueous solution of ferrous chloride with gaseous oxygen at a temperature of about 100 to 115 C and a pressure of about 20 to 80 psig for a time sufficient to solubilize copper and zinc, (2) filtering the resulting reaction mixture, (3) precipitating copper from the filtrate by addition of metallic iron, (4) treating the resulting copper-free filtrate for removal of zinc by solvent extraction and recycling the resulting ferrous chloride solution to step (1), (5) treating the residue from step (2) with an alkaline solution of sodium cyanide to solubilize the silver, and (6) electrolyzing the silver solution from step (5) to recover metallic silver.)

NON-FERROUS METALS INDUSTRIES

IN THE NEWS

ISSUE NO. 2, August, 1977

A bimonthly publication service by the USEPA Metals and Inorganic Chemicals Branch of the Office of Research and Development designed to spotlight selected events, activities, and concerns in the nonferrous metals-producing industries.

HIGHLIGHTS: ● Because of escalating costs and slumping prices, several copper facilities are closing or curtailing production operations. ● Zinc market conditions and prices are also forcing production cutbacks in several domestic plants. ● Discovery of a large zinc-copper-sulfide deposit near Crandon, Wisconsin, was announced by Exxon. ● Continuing strong market and attractive pricing are sparking new and renewed activity in silver operations.

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Aluminum

(1) Alumax, in cooperation with Mitsui of Japan, is planning construction of a 187,300 ton per year smelter in Umatilla, Oregon, pending environmental impact statements by the Bonneville Power Administration (suppliers of the electrical power). Also in planning by Alumax is an 88,000 ton per year potline at Eastalco's smelter in Frederick, Maryland, a joint venture with Howmet Aluminum.

(2) An automated system for control of aluminum electrolysis has been introduced at the Volkhov Aluminum Plant in Kirov, USSR. Increased purity is obtained together with 50 percent greater production. (No further details were given.)

(3) Alcoa has built a 15,000 ton per year demonstration unit at Palestine, Texas, to recover volatile chlorides from fly ash. Magnetic separation removes the iron oxides; then the nonmagnetic material is chlorinated at high temperature.

Copper

(4) All permits, except for the tailings pond discharge and several roads, have been obtained by Quintana Minerals, for the development of a copper mining and processing project at Hillsboro in Sierra County, New Mexico.

(5) Construction is already underway by Anaconda near Tooele, Utah, (Carr Fork Project) for a multimillion dollar underground copper mine and surface metallurgical processing facilities. Operations are to commence by mid-1979.

(6) Exhaust heat from power plant engines is being used to heat the fabric covering to 180-190 F on three vacuum drum filters for dewatering copper concentrate. This new system is being installed at the Twin Buttes, Arizona, concentrator of Anamax Mining Company to replace gas fired driers and solar drying ponds. Water is collected for recycle.

(7) The first commercial copper smelter designed and engineered by Dravo using the TBRC smelter oxygen-oriented technology will be operated by Afton Mines, Ltd., Kamloops, B.C. Originally developed in Sweden to produce steel from high phosphorus iron ore, and known as the Kaldo Process, it was converted to nickel processing by Inco, then to copper smelting by Dravo and Inco in 1973. The TBRC Process produces a purer product and cleaner slags, improved process control, higher SO_2 concentrations, better exhaust gas collection, high energy efficiency, and lower capital and operating costs.

(8) The chances at this time appear quite favorable that the "Ely Amendment" to the Clean Air Act will be enacted. This amendment exempts smelters in business prior to 1910 from extensive plant alterations to lower sulfur oxide emissions. Closure of the Phelps Dodge Douglas Reduction Works and the McGill, Nevada, smelter would thus be prevented, as neither could afford the investments in pollution controls that were to be required.

(9) Adverse effects of recent economic trends will affect a number of copper operations. The Cyprus Bruce Copper and Zinc Company mine near Bagdad, Arizona, will close because of the depressed prices, escalating smelter and refining costs, and the depletion of ore reserves.

On September 1, Anaconda's Victoria, Nevada, mine will close indefinitely because of the present economic conditions in the copper market. Resumption of operations will depend on the future market price for copper and development of ore reserves in the area. In 1981, Anaconda will close permanently its Weed Heights, Nevada, operation. Layoffs will begin as early as 1979 as oxide ores begin to give out. The Duval Corporation will close three western mines for 6 weeks (August 8-September 18), then follow with a 5-day work week indefinitely until there is a notable improvement in the depressed state of the copper market. Production will be cut 33 percent as a result. Phelps Dodge's Morenci, Metcalf, and Ajo mines in Arizona and its Tyrone, New Mexico, mine will go on 5-1/2-day shifts indefinitely, thus cutting production to 85 percent of capacity.

Cities Service Miami operations in Arizona will not reopen its Pinto Valley mine and mill due to the high cost of the strike settlement. The solvent extraction electrowinning plant will continue operations.

(10) Phelps Dodge will be allowed to continue capacity operation of its Playas, New Mexico, copper smelter until December 31, 1977, while it is constructing an additional sulfuric acid plant to help control sulfur emissions.

Molybdenum

(11) In July, the Henderson mine/mill complex of Amax, Inc., and Climax Molybdenum Company was dedicated. At full scale production in 1980, 30,000 tons of 0.5 percent molybdenum disulfide ore will be mined and processed per day. One of the first mines designed to meet the environmental standards of the past decade, the ore is hauled by a 15 mile railroad to the mill across the Continental Divide to prevent pollution of a key watershed in the area.

(12) Kennecott Copper and Molycorp jointly are proceeding with Phase 2 of the plan to develop the Questa, New Mexico, mine property. This calls for mining 15,442,000 tons of 0.154 percent molybdenum sulfide ore between May, 1977, and the end of 1979. This figure includes 9,370,000 tons of stockpiled,0.132 percent ore. The partnership has also been studying the

Goat Hill area nearby, for an underground mine, with reserves of 100,900,000 tons grading 0.32 percent molybdenum desulfide.

(13) A portable "Mud Cat" dredge operated by only two workers is being used to clear sludge from a secondary holding pond at the Amax Henderson molybdenum mine west of Denver, Colorado. Mounted on a floating barge, it can clean to a depth of 10-1/2 feet at the rate of 80 cubic yards per hour and does not interfere with the operation of the pond while being used.

(14) Amax Exploration reports a possible major molybdenum deposit on Mt. Emmons near Crested Butte, Colorado. In nine of ten drill holes assayed, mineralization ranging from 0.2 to 1 percent molybdenum disulfide was found. At an average depth of 1200 feet, the mineralization was 300 feet thick and contained an estimated 90 million tons. Additional study of the deposit is being made to determine its continuity and feasibility for mining.

Silver

(15) Hecla Mining Company has reported a possible major silver strike directly under the old abandoned Gold Hunter mine in the Coeur d'Alene district of Idaho.

(16) Reserves of 10 million tons of silver ore (averaging 3.2 oz/ton) on the Taylor property of Silver King Mines in Nevada have been reported. Feasibility and costs studies for building a 2000-tons-per-day cyanide leaching plant on the site have been made. Cost is estimated at $7.7 million . Silver-gold ore from the East Robinson property and silver from the East Hamilton property will also be processed here.

Silver King is also conducting test drilling on the Ward property where 10 million tons of ore reserve is indicated, averaging 1.8 ounces silver, 60 pounds zinc, and 30 pounds of copper per ton.

(17) Production is being resumed at the Deer Trail mine at Marysvale, Utah, after being closed since 1971. The lead-zinc-silver ore, ranging from 500 to 800 tons per month is being shipped to the flotation plant at Park City, Utah.

Zinc

(18) What is believed to be one of the five largest massive zinc-copper sulfide deposits in North America has been discovered near Crandon, Wisconsin, by Exxon. About 75 million tons of ore analyzing 5 percent zinc and 1 percent copper are indicated.

(19) Recent equipment failure in the concentrate roaster sulfuric acid recovery system of the Amax Zinc Company, Sauget, Illinois, plant will force plant shutdown in September. This will reduce zinc production by 15 percent.

(20) Because of the continued weakness of the domestic zinc market and worldwide oversupply, a number of zinc producers throughout the world have reduced operations. In the U.S., Bunker Hill will operate its mines and refinery at 70 percent capacity; St. Joe Zinc Company began cutbacks in June; and Asarco is believed to have cut back 60 percent.

Zirconium

(21) Unacceptably high levels of radioactivity in the form of radium-226 was found in the Albany, Oregon, zirconium plant of Teledyne Wah Chang. Hazardous levels of chlorine, phosgene, and ammonia were found in the plant and, in addition, a landfill of zirconium waste caught fire while being bulldozed. A fine was levied for the violations.

Miscellaneous

(22) The USSR has developed a superconducting infrared radiometer for ore prospecting in an airplane flying at 200-300 meters. The bolometer is encased in a cryostat at a temperature of -269 C. A superconductor magnetometer has also been developed. One measures the earth's magnetic field variations outside the ore anomaly, the other in the area of the anomaly. A comparison of the two instruments provides data for calculating the ore deposit.

(23) A new process developed by the Permutit Company, the Sulfex process, removes heavy metals from wastewaters by precipitation as sulfides. The process removes most chelated metals and reduces hexavalent chromium as the other metals are precipitated as sulfides. Two units are used; the first removes a large part of the metals as hydroxides, the second precipitates the remainder as sulfides. Permutit will install two 40 gpm plants by the end of this year.

(24) There is a vast energy-saving potential through recycling of metals, and American industry has just scratched the surface. Environmental and economic dividends are the conservation of natural resources, 80-90 percent less air pollution and 75 percent less water pollution, relative to primary processing, reduced reliance on foreign sources, alleviation of balance of payments problems, and increased employment. A ton of aluminum or copper, made from scrap, saves 95 percent of the energy needed to produce a ton from virgin material. The energy savings in equivalent barrels of oil from recycling aluminum, copper, zinc, lead, and iron and steel last year was 126,000,000.

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(5) Arizona Paydirt, (456), 43 (June, 1977).

(6) Mining Congress Journal, 63 (7), 10 (July, 1977).

(7) Dravo Trade Literature "TBRC Smelter Process for Copper".

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(10) New Mexico Paydirt, (1), 38 (June, 1977).

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American Metal Market, 85 (134), 9 (July 13, 1977).

(12) American Metal Market, 85 (150), 1, 8 (August 4, 1977).

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(14) American Metal Market, 85 (161), 17 (August 19, 1977).

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(16) Skillings Mining Review, 66 (29), 4 (July 16, 1977).
The Mining Record, 88 (33), 1 (August 17, 1977).

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RECENT PATENTS

4,032,330
PROCESS FOR RECOVERY OF COPPER
Gerald F. Fountain; Jaime Veloz; Harry R. Dahlberg, and Edward A. Bilson, all of Inspiration, Arizona, assignors to Inspiration Consolidated Copper Company, Morristown, New Jersey.

(A process for the leaching and recovery of copper values from sulfidic copper ore.)

4,032,331
PROCESS FOR CONSERVING QUINOLIC COMPOUNDS IN AN ORGANIC EXTRACTANT COPPER RECOVERY SYSTEM
John N. Gerlach, Burlington, Massachusetts, assignor to Kennecott Copper Corporation, New York, New York.

4,032,332
PROCESS FOR INCREASING THE RATE OF COPPER METAL PRODUCTION IN A QUINOLIC EXTRACTION SYSTEM
John N. Gerlach, Burlington, Massachusetts, assignor to Kennecott Copper Corporation, New York, New York.

4,033,757
CARBOTHERMIC REDUCTION PROCESS
Robert Milton Kibby, Richmond, Virginia, assignor to Reynolds Metals Company, Richmond, Virginia.

(An electric furnace carbothermic process for the production of aluminum from an aluminum oxide.)

4,033,761
PROCESS FOR THE SEPARATION OF COPPER SULFIDE FROM METALLIC LEAD ENTRAINED IN A DROSS
Carl Richard DiMartini, Piscataway; William Lafayette Scott, Lebanon, and Leo James Bulvanoski, Fords, all of New Jersey, assignors to Asarco Incorporated, New York, New York.

4,033,846
APPARATUS FOR GAS COLLECTION IN ALUMINUM SMELTING FURNACES
Arne Engesland, Mosjoen, Norway, assignor to Lista Og Mosjoen Aluminiumverk, Elkem Aluminum A/S & Co., Oslo, Norway.

4,034,063
PROCESS FOR CONTROL OF SO_x EMISSIONS FROM COPPER SMELTER OPERATIONS
Edward C. Rosar, Lakewood, Colorado; Jacques M. Dulin, Libertyville, Illinois; Joseph M. Genco, Gahanna, and Harvey S. Rosenberg, Columbus, both of Ohio, assignors to Industrial Resources, Inc., Chicago, Illinois.

(Soda-scrubbing of stack gas, and using the (NaS_xO_y) product to remove iron from spent leach/cementation liquor, allowing liquor recycle.)

4,036,636

PYROMETALLURGICAL PROCESS FOR SMELTING NICKEL AND NICKEL-COPPER CONCENTRATES INCLUDING SLAG TREATMENT

Paul R. Ammann, Boxford, and Jonathan J. Kim, Chelmsford, both of Massachusetts, assignors to Kennecott Copper Corporation, New York, New York.

4,036,639

PRODUCTION OF COPPER

William J. Yurko, Edmonton, Canada, assignor to Sherritt Gordon Mines Limited, Toronto, Canada.

(A hydrometallurgical process for recovering copper from cupriferous sulphidic material.)

4,036,931

BAYER PROCESS PRODUCTION OF ALUMINA

Morris L. Roberson; John W. Beck; Jack S. Maples, all of Baton Rouge; Anthony Savariste, Plaquemine, all of Louisiana; Donald J. Donaldson, Orinda, California; David L. Stein and Allan C. Kelly, both of Pleasanton, California, assignors to Kaiser Aluminum & Chemical Corporation, Oakland, California.

(Blowdown of spent liquor with CO_2 to recover Al_2O_3 as sodium dawsonite, producing environmentally acceptable waste with pH from 8.6-9.)

4,038,039

PRODUCTION OF ALUMINA

Andrew Nicolson Carruthers, Dollard des Ormaux; John Edward Deutschman, and Michael George Willis, both of Arvida, all of Canada, assignors to Alcan Research and Development Limited, Montreal, Canada.

(A procedure for controlling the sodium oxalate level in the liquor employed in the Bayer process for the production of alumina from bauxite ore.)

4,038,070

LOW TEMPERATURE AND PRESSURE CONTINUOUS REDUCTION OF COPPER IN ACID SOLUTIONS

Alkis S. Rappas, Arlington, and J. Paul Pemsler, Lexington, both of Massachusetts, assignors to Kennecott Copper Corporation, New York, New York.

(Hydrogen reduction to Cu^+, complexing, and disproportionation.)

4,038,361

RECOVERY OF NITRIC ACID SOLUBLE TRANSITION METALS FROM SULFUR AND IRON CONTAINING ORES OF THE SAME

John G. Posel, Everett, Washington, assignor to International Ore Technology, Inc., Highland Mills, New York.

(A pressurized hydrometallurgical method of recovering one or more metal values of the group consisting of copper, silver, nickel, cobalt, and zinc from a sulfur and iron containing ore.)

4,039,401
ALUMINUM PRODUCTION METHOD WITH ELECTRODES FOR ALUMINUM REDUCTION CELLS
Koichi Yamada; Tadanori Hashimoto, and Kazuo Horinouchi, all of Niihama, Japan, assignors to Sumitomo Chemical Company, Limited, Osaka, Japan.

(A method for producing aluminum by molten salt electrolysis of aluminum oxide using ceramic electrodes.)

4,039,404
CYCLIC PROCESS USING A.C. FOR SELECTIVE RECOVERY OF METALS FROM MATERIALS CONTAINING SAME
Kenneth Julian Richards, Salt Lake City, and Don Richard Clark, Centerville, both of Utah, assignors to Kennecott Copper Corporation, New York, New York.

4,039,405
LEACHING COPPER ORES AND SOLVENT EXTRACTION OF THE COPPER-BEARING SOLUTIONS
Soon Y. Wong, Ponca City, Oklahoma, assignor to Continental Oil Company, Ponca City, Oklahoma.

4,039,406
RECOVERING COPPER FROM CONCENTRATES WITH INSOLUBLE SULFATE FORMING LEACH
Robert W. Stanley, Kirkland, and Kohur Nagaraja Subramanian, Mississauga, both of Canada, assignors to Noranda Mines Limited, Canada.

(A hydrometallurgical method of recovering copper values from copper sulphide concentrates.)

4,042,664
METHOD FOR SEPARATING METAL CONSTITUENTS FROM OCEAN FLOOR NODULES
Paul H. Cardwell, Zanoni, and William S. Kane, Wicomico, both of Virginia, assignors to Deepsea Ventures, Inc., Gloucester Point, Virginia.

(Carbo-halogenation dissolution and liquid-liquid extraction.)

* * * * * *

Individually contributed news items may be submitted to Mr. Fred Craig, Metals and Inorganic Chemicals Branch, IERL, USEPA, 5555 Ridge Avenue, Cincinnati, Ohio 45268 (Phone 513-684-4491).

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USEPA AWARENESS BULLETIN

TECHNOLOGY & TRENDS

IN THE NONFERROUS METALS INDUSTRY

The following pages are abstracts of nonferrous metals technology and operations appearing in the literature within the past 2 or 3 months. The indexing system is designed to facilitate filing according to user interest by a "primary-secondary-tertiary" coding system for "metals-processes-environmental concern" as follows:

Metals

1. Cu (and As, Se, Te)*
2. Pb, Zn (Sb, Cd, Tl)
3. Al (Ga)
4. Ti (Zr, Hf)
5. Mo (Re, Sn)
6. Rare Earths and Y
7. Be
8. Hg
9. Ag, Au, Pt, Pd
10. W
11. V, Cr
12. Cb, Ta
13. Ni (Co, Mn)
14. Mg
15. Multiple
16. Unspecified

Process

.1 Mining (P)**
.2 Beneficiation (P)
.3 Smelting/Extraction (P)
.4 Refining (P and S)
.5 Ingot Melting (P and S)
.6 Preparation (S)
.7 Smelting/Extraction (S)
.8 General Recycling (S)
.9 Multiple (P and S)

Environmental Concern

.1 Air (Human)
.2 Air (Ecology)
.3 Water (Human)
.4 Water (Ecology)
.5 Solid (Human)
.6 Solid (Ecology)
.7 Noise
.8 Multiple
.9 Not Determined

* ( ) = common byproducts
** ( ) = primary or secondary

Subject: New Techniques in Copper Mining

At the present time, about 55 percent of the copper mine production is from underground mines and 45 percent from open pit. Depending upon the method used in underground mining, the cost per ton of ore ($1.60) will generally be 1-1/2 to 6 times that of open pit mined copper. Worldwide, decline in the overall average grade of copper mined (0.53 percent in the U.S.) will increase production costs, necessitating improvement in production techniques. This paper describes some of these new techniques.

Underground Mining. The newest technique in shaft sinking involves large diameter rotary drilling, eliminating the need for blasting and personnel below ground level. Holes for ventilation or secondary service shafts have been drilled to 8 meters in diameter and 500 meters deep. Other improvements in shaft sinking are mechanical devices to remove broken rock from shaft bottoms and the drilling of pilot holes and their subsequent enlargement.

Self-propelled rock cutting machines, similar to those used in the coal mines, are being used in place of the drilling and blasting formerly used. Boring machines are 4 to 5 times faster than conventional blasting techniques in tunnel driving.

Haulage of the ore to the surface in diesel-powered trucks up inclined surface drifts is replacing the small cars pulled by locomotives, or vertical shaft lifts. Hydraulic transport and hoisting, already used in coal, iron, and gold mining, may become used for copper in the future.

Open Pit Mining. Innovations in above ground mining include the use of the explosive ANFO (ammonium nitrate and fuel oil), smaller and more mobile rotary drills, bucket-wheel excavators, and off-highway trucks with load capacities of up to 300 tons.

Heap leaching is being increasingly used to extract copper from the ore. In heap leaching, the ore is stacked in piles through which the leaching solution is passed. In situ leaching is of continued interest, and several sites are being developed with in situ leaching in mind. In this process, the explosive-shattered mineralized rock is leached in place. Fragmentation of copper ore deposits may, in the future, be done by nuclear explosives.

Environmentally, solution mining is advantageous as there are no tailings to dispose of, no smelting to cause air polution, and little surface disturbance.

Reference: R. C. Howard-Goldsmith, Mining Magazine, 138 (2), February 1978, pp. 111, 113, 115, 117, 118

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SUBJECT: The TL Leaching Process

A new leaching process, called TL (for thin layer), has been developed by Holmes and Narver of Anaheim, California. The first commercial TL plant will be built in Santiago, Chile, to handle 2,500 tons of copper ore per day.

After crushing, the ore is contacted with concentrated acid in a rotating drum, allowed to "cure" for 24 hours, then spread to dry in 3-foot deep leach beds. During the leaching cycle, water or weak leach liquor is periodically sprinkled over the bed, and the leachate is collected beneath the bed. Exhausted beds, which are quite dry, are dumped into a landfill. Because disposal of the exhausted beds is done in the dry state rather than impoundment of wet tailings as conventional processes, the chance of ground water contamination is virtually eliminated.

REFERENCE: Mining Journal, 289, (7404), July 15, 1977, pp. 47-48.
Chemical Engineering, 84, (15), July 18, 1977, p. 53.

Subject: Pinto Valley Tailings Disposal Project Underway

With an eye to future requirements, work is proceeding on the $6 million tailings impoundment project at the Cities Service Pinto Valley Arizona copper operations. Scheduled for completion in January, 1978, the structure will cover 525 acres and is designed to contain 234 million tons of tailings, (20 years production from the Pinto Valley concentrates). Flowing at a rate of 13,700 gal per minute, the tailings will flow through 3 miles of 24-inch concrete-lined steel pipe into the tailings pond which, when filled will run 650 feet, believed to be the world's deepest.

As an environmental protection feature, a 13,300-foot-long pollution-control ditch is being constructed around the tailings disposal pond. Nearly one-half million cubic yards of excavation will be required for the control ditch.

Reference: Skilling's Mining Review, 66, (44), October 29, 1977, p. 17

Subject: Cyprus Bagdad's $240 Million Expansion Nearing Rated Production

In the early 1970's, with a 6000 tpd operation facing a declining ore grade, increasing cost, and obsolete facilities, but with a 300-million-ton (0.49 percent copper) reserve, Bagdad decided to expand its operation. A merger with Cyprus Mines and an arrangement with Phelps Dodge to smelt the concentrate at its new Hidalgo smelter in New Mexico were preliminary steps to the beginning of the $240 million expansion in the spring of 1975.

The old mill was closed in August, 1977, with the new concentrator beginning operation in September. As additional circuits came on line, production increased and stood at 38,000 tpd at the end of February, 1978.

The processing facilities consist of (1) primary crushing and conveying, (2) autogenous primary grinding with crushed ore recycle, (3) ball-mill secondary grinding, (4) copper-moly flotation, (5) moly flotation, (6) concentrate filtering and drying, (7) tailings disposal and water reclaim, and (8) cincillary facilities. Details of each of the processing facilities are given in the article, together with a concentrator flow diagram.

The mining operation is a high volume one, 1-1/2 tons of waste rock must be removed for every ton of ore or 10 pounds of copper metal. Loading is done with four 20-yard electric shovels and hauling with twenty-two 170-ton trucks over well-maintained roads. Grades at the shovel are maintained by laser beams and slope movement is detected by an infrared distance meter, which can detect movements of 0.001 foot at 10,000 feet.

The four primary reasons given for success in meeting its goal of "moving muck" are (1) open door personal relations policy, (2) excellent preventive maintenance policy, (3) excellent haul road maintenance, and (4) using shovels to load, not to dig.

Reference: Arizona Paydirt (465), March, 1978, pp. 4-9.

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SUBJECT: Cyprus Bagdad's Solvent Exchange Process

Cyprus Bagdad is completing a $240 million solvent exchange expansion program designed to recover 20 tons per day of cathode copper from dump-leach operations for its oxide/sulfide ores mined at the Bagdad, Arizona, site. Earlier operations were based on iron cementation followed by smelting/refining. Copper/iron price changes, the scarcity of cement iron, and cost and capacity constraints relative to smelting were ingredients that contributed to the decision to invest in the LIX-electrowinning route.

The new plant design will process about 3200 gpm of dilute sulfuric (1.89 g/L) leach liquor containing 1.07 g/L copper. Dumps are contained in narrow canyons and are treated with acid at an initial concentration of 7.73 g/L at a rate of 1 gallon of acid per 44 square feet of dump area applied through a "wiggler" over the surface of the dumps. Percolating leach liquor is collected in sumps without measurable seepage to ground water, and pumped to a surge pond (750,000-gallon capacity) which feeds the extraction and electrowinning plant.

Extraction is done in four modules, each operating at a flow of pregnant liquor at 800-925 gpm. The extractant, 6.36 percent LIX64N in 93.64 percent Napoleum 470, is counterflowed at a 1:1 ratio against the throughflowing pregnant leach solution. The LIX exchanges a hydrogen ion for copper, at once extracting the copper and regenerating the acid for recycle. Disengagement settling occurs at a rate of greater than 2 gpm per square foot area of the settling vats. The recovered pregnant extractant is stripped and regenerated by an acid copper sulfate solution prior to recycle. The enriched stripper solution passes to the tankhouse where starter sheets and cathodes are produced while decreasing the copper concentration of the electrolyte from about 60 g/L to about 30 g/L before it is recirculated to the stripper plant. The quality of the cathodes thus electrowon is comparable with electrorefined cathode.

Several problems encountered in start-up of this plant were briefly discussed. These included hydrostatic leakage from miles of piping (corrected by segmental isolation and correcting), cleansing the extractant solution of soluble organics (operational "nurse-maiding"), and learning to treat stripper sludge to preserve organic values.

A bottom-line comparison of actual with projected costs for this operation showed excellent agreement, and significant operating cost advantages for solvent extraction and electrowinning over the previous method of cementation and smelting/refining were indicated. (Cost of capital and depreciation comparisons were not included, however.)

REFERENCE: R. L. Jones, Mining Engineering, 29 (9), September, 1977, pp. 38-42.

SUBJECT: Asarco Takes "Zig-Zag" Path to Improve In-Plant Control of Particulate Pollution

Asarco has installed Patterson-Kelley zig-zag continuous liquid-solids blenders at three points in its Tacoma, Washington, smelter and at two other facilities. Although used primarily for blending and agglomerating in the chemical processing industry, distinctive features of the zig-zag process suggest its use in pollution problems.

The blender consists of a stationary inlet and stationary discharge with a rotating eccentric drum and a series of legs mounted on a slightly inclined frame in between. Liquids are injected into the blender through adjustable orifices inside the rotating drum. This action coats every particle, however small, with liquid. Located in the discharge line from electrostatic precipitators, the zig-zag blender not only provides a simple means of agglomerating the precipitator product but also eliminates a laborious and dusty materials handling operation.

At the Asarco copper smelter in Tacoma, arsenic oxide from the electrostatic precipitators is agglomerated in the blender and advanced to the roasting plant for processing to arsenic trioxide. In two other operations at the Tacoma facility, dusting problems have been solved and valuable dust recovered.

As Asarco has proven in these installations, the pollution problem of various smelter dusts can be greatly alleviated by the use of the zig-zag blender.

REFERENCE: Engineering Mining Journal, 178 (7), July, 1977, pp. 101-102.

Subject: Cyprus Reveals Details of New Copper Process

As reported in the September-October 1977 issue, Cyprus Copper has developed a new hydrometallurgical copper process. Some additional information has been forthcoming and is presented here.

The copper ore concentrate (sulfide or oxide) is slurried in strong ferric and cupric chlorides. When leached at atmospheric pressure and temperatures below 100 C with cupric chloride, cuprous chloride, ferrous chloride, elemental sulfur, and free acids are formed. After hot filtration, lowering the temperature of the filtrate results in crystallization of the cuprous chloride.

Hydrogen reduction of the cuprous chloride takes place in a fluidized bed of sand, at less than 1000 C. The copper agglomerates with the sand particles and the agglomerate is removed from the bed when the copper-sand ratio becomes 92%:8%. In a commercial plant, the agglomerates would be melted in a reverberatory furnace with sand and minor impurities removed as slag during fire refining.

The sulfur is recovered as free sulfur; consequently, no SO_2 pollution takes place. The hydro circuit is closed, and water is required for evaporative makeup and cooling only. Iron is removed as stable jarosite, which, along with sulfur, smelter slag, and leach tailings, is the predominant solid waste.

Reference: Engineering and Mining Journal, 178 (11), November, 1977, pp. 27, 31, 33

Subject: Chronic Sulfur Dioxide Exposure in a Smelter

A detailed review and assessment of airborne pollutants and respirophysiological effects within a copper smelter is presented. Historical data are given which resulted in a significant lowering of SO_2 levels near a reverberatory smelting furnace that was associated with the provision of positive ventilation in 1969.

Although area measurements indicated mean shift SO_2 concentrations varying from about 1 to 32 mg/m^3, sampling units worn by workers and deactivated when respirators were used showed much more uniform personal dosages from about 2 to 4 mg/m^3. The workers obviously avoid breathing SO_2, do not linger in areas that are apt to have high SO_2 levels, and wear respirators when performing functions in such areas.

For comparison purposes, 953 smelter workers were surveyed and physiological responses compared with a "control" group of 252 mine equipment maintenance shop workers (SO_2 levels $\lesssim 0.2\ mg/m^3$). For these comparisons, SO_2 level in the workplace was the principal difference. Sick-leave statistics and spirometric evaluations were among the comparative evaluation criteria. Three factors were found to be significant in the analysis: (1) smelter versus shop location, (2) smoking habits, and (3) years worked (either smelter or shop). Within this matrix, it was concluded that chronic SO_2 effects do accrue to the SO_2 dosage associated with smelter (as opposed to shop) work. The severity of effects from smoking and SO_2 inhalation appear similar, and both become more pronounced with continued exposure (e.g., the difference between the <10-year population and the >20-year population is notable). Further, the effects of SO_2 exposure and smoking are approximately additive. Some anomalies were apparent in the spirometric evaluations (e.g., nonsmoking shop workers have higher forced vital capacities and forced expiratory volumes relative to predictions as they grow older), but these are not sufficient to invalidate the principal conclusion that neither smoking nor SO_2 inhalation is a particularly healthy practice.

As a result of this study of chronic (versus acute) effects, the authors suggest reconsideration of the time-weighted average of SO_2 environmental standards.

Reference: T. Smith, W. Wagner, and D. Moore, J. Occupational Medicine, 20 (2), Feb. 1978, pp. 83-95.

Subject: Arsenic Poses Tricky Recovery Task

The toxicity of arsenic has become a very controversial subject, both in Canada and the U.S. New governmental regulations are expected momentarily in both countries.

Gold smelters in Canada are the source of most of the arsenic trioxide fumes, and these smelters have pioneered the technology for As_2O_3 removal from the air. An arsenic recovery unit, built at Campbell Red Lake Mines in Balmertown, Ontario, is the latest of many such units built by gold producers. It is claimed to reduce arsenic concentration at ground level to <1 ppb.

Initial cooling of roaster gases to 370 C allows dusts and gold to be collected by an electrostatic precipitator while arsenic remains in vapor form. A mixture of 12,000 m^3/hr roaster gases and 18,000 m^3/hr of cooling air is then passed through a specially designed mixer which lowers the temperature to 100 C, resulting in the condensation of the arsenic trioxide vapor into a powdery solid. The powder is collected by a bag filter from the gas stream.

Reference: H. Goodfellow, M. Gellender, Canadian Chemical Processing, 62 (2), February, 1978, pp. 26-27.

SUBJECT: Cyprus Completes New Copper Process

A new hydrometallurgical copper process was announced by Cyprus Mines. Applicable to a spectrum of copper concentrates, the process embodies (1) ferric chloride leaching to produce dissolved cuprous chloride, (2) crystallization of CuCl from the leach liquor, (3) hydrogen reduction of CuCl to metallic copper in a fluidized bed, and (4) fire refining. Wire bar produced by this method has been drawn to wire that meets industrial specifications.

According to estimates made by Jacobs Engineering Co. for Cyprus, the capitalization necessary for a 75,000 ton/year plant to process output from the company's Bagdad, Arizona, mine and concentrator would be $73 million, or slightly less than $1000/AT. This is less than half the cost estimated for a pyrometallurgical plant. Operating costs would be about one-half of what Cyprus pays for toll smelting and refining. Particularly attractive features include no SO_2 emissions (sulfur is recovered in elemental form), hydrogen reduction rather than electrowinning of copper, and recovery of byproducts such as molybdenum, silver, lead, zinc, and gold.

Cyprus hopes to license this pollution-free process to other operators.

REFERENCE: Skillings' Mining Review, 66 (38), September 17, 1977, p. 33.
Skillings' Mining Review, 66 (42), October 15, 1977, p. 18.

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SUBJECT: New Oxidative Leaching Process
Uses Silver to Enhance Copper Recovery

Bench tests at C-E Lummus of a hydrometallurgical process for copper are described. Chalcopyrite or mixed chalcocite/chalcopyrite concentrates were oxidation-leached in acidified ferric sulfate at ambient pressure to dissolve copper as cupric sulfate, producing elemental sulfur which may be recovered as a byproduct. The key to effective leaching was the addition of 200-300 ppm of silver to the leach slurry. Extraction of up to 97 percent of the copper in single-stage, and 99 percent in two-stage leaching has been demonstrated. The silver apparently catalyzes the leaching. It selectively (97 percent) reports to the tailings cake, from which it is recovered to levels of about 99 percent for recycle. Based on the laboratory bench tests, silver consumption (loss) on the order of 2 to 3 oz per ton of copper produced might be expected.

The pregnant leach liquor containing copper values is pH-adjusted and oxidized to regenerate ferric sulfate for recycle. This also generates some iron oxide, basic ferric sulfate, and calcium sulfate as solid waste products. Copper is extracted from the liquor (LIX-64) and electrowon after stripping (and regenerating) the extract with H_2SO_4.

The leach tailings circuit comprises stripping the elemental sulfur with hot-water washing (to melt the sulfur) and pressure filtering. The tailings are then leached in hot concentrated H_2SO_4 and washed to remove the dissolved silver. Silver is cemented from the filtered liquid and separated by decanting or filtering, redissolved, and recycled to the primary leaching stage.

A schematic flow diagram is presented for the total process. As is characteristic of hydrometallurgical processing of copper concentrates, a major desirable feature is the lack of gaseous SO_2 emissions. Major effluents would be process waters with contained solids (Fe_2O_3, $Fe(OH)SO_4$, and $CaSO_4$), and process tailings, stripped of sulfur, silver, and precious metals, if warranted. Rigorous material balances have not yet been developed.

REFERENCE: G. J. Snell and M. C. Sze, Engineer and Mining Journal, 178 (10), October, 1977, pp. 100-105.

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SUBJECT: The Evaluation of Four Potential Hydrometallurgical Processes for Copper Production

A recent renewal of interest in hydrometallurgical processes for copper production has taken place. In the U.S., the driving force behind this renewed interest is sulfur dioxide pollution from smelters.

At the present time, there are about ten hydrometallurgical processes for copper recovery in the development stage. Flowsheets of four of these processes are shown in the article. The Cymet and Arbiter methods are the most advanced.

For hydrometallurgy to be economically viable, a capitalization of no more than $800/ton and operating costs less than $.05/kg of copper must be achieved. Hydrometallurgy is generally uneconomical based on these criteria.

Presently, none of the four hydrometallurgical processes are competitive with established large-scale pyrometallurgical practice, with the possible exception of the Cymet process. However, specific conditions (ore type, metal recovery, disposal problems, by-product utilization, and plant capacity) could produce particular circumstances where a "tailored" hydrometallurgical process would be competitive.

Elimination of sulfur dioxide emissions is the prime advantage of hydrometallurgy over pyrometallurgy.

REFERENCE: O. Sitnai and P. K. Peeler, Proceedings of the Australasian Institute of Mining and Metallurgy, (216), March, 1977, pp. 21-30.

SUBJECT: Copper from Chalcopyrite by Direct Reduction

Direct reduction of chalcopyrite flotation concentrate is a proposed process for "pollution free" copper production.

Water vapor is the only gaseous reaction product according to the equation for the reaction:

$$CuFeS_2 + 2\ CaO + 2\ H_2 \rightarrow Cu + Fe + 2\ CaS + 2\ H_2O$$

In research studies, the chalcopyrite concentrate was pelletized and reacted with H_2 and CaO in a rotary kiln at 800 C. The original pellet form was retained, allowing the copper and iron to be removed by screening or by a magnet. The iron was leached from copper with HCl. The resulting $FeCl_2$ could be spray oxidized in a special furnace to Fe_2O_3 and HCl, with the HCl being recycled to the leaching step. The CaS can be oxidized at 500 C to $CaSO_4$.

Environmentally, this is a potentially clean process, with water vapor as the only gaseous effluent and gypsum and Fe_2O_3 the only solid by-products. Although technology has been demonstrated, economics were not addressed in this paper, nor were process specifics treated to the degree required to allow assessment of requirements for overall environmental control.

REFERENCE: F. Habashi and B. I. Yostos, Journal of Metals, 29 (7), July, 1977, pp. 11-16.

Subject: Smelting Practice at Anaconda, Montana

From its beginnings in the late 19th century, Anaconda's copper concentrating and smelting operations at Anaconda and Butte, Montana, have undergone numerous additions and modifications. In 1977, electric furnace smelting totally replaced reverberatory furnace smelting. A review of the operations practiced by the smelter at Anaconda is presented in this article.

About half of the smelter feed comes as a slurry from Anaconda's nearby C. E. Weed concentrator in Butte, with the rest coming from more distant Anaconda facilities. Feed includes cement copper from dump leaching and a variety of copper-bearing minerals. Some toll smelting is also done at Anaconda. Feed is pumped from storage bins at a repulping station, thence to surge tanks prior to entry in a fluidized roaster for partial roasting. The hot roasted feed is then conveyed and charged in the electric furnace for smelting to a matte that typically contains 50 to 55 percent copper. (This is higher-grade than the prior reverb matte that contained about 35 percent copper.) Optimum production scheduling calls for blowing of the matte in two convertors, although a third converter was implied to be necessary at times. Convertor slags are returned to the electric furnace to recover the contained copper. Blister copper proceeds to anode furnaces for additional refining and casting into anodes for electrorefining. Unit operations for the fluosolids reactor (roaster) and the electric furnace smelter are given along with monthly materials flows and compositions.

In 1970, it became necessary to upgrade the gaseous effluent treatment and control system due in part to the antiquity of the original system, and in part to anticipated regulatory actions. The current system includes a new flue system and baghouse, wet-scrubbing tower, venturi precipitator, and double-contact acid plant. Prior operations seldom violated ambient air standards, partly because of the "highest stack in the world", but the new system was installed at a cost of $66.5 million to date. The acid plant is presently being modified to treat gases containing up to 9 percent SO_2, and will have a capacity of 1320 tpd of H_2SO_4.

Reference: J. B. McCoy, Mining Congress Journal, 63 (10), October 1977, pp. 45-50.

Subject: Automation Aids Inspiration's Clean Air Program

Process control features of the Inspiration Consolidated Copper Company's 3-year-old copper smelting complex in Arizona are described. Temperature, pressure, offgas, and acid plant measurements and apparatus are discussed. The complex features a large electric furnace smelting furnace, five large Hoboken syphon converters (of which three operate simultaneously, but only one blows at a time), and a double contact acid plant. Its construction was guided by the need to employ process controls to permit conformance to ambient air regulations. Control systems are continually upgraded and maintained to achieve optimum operations commensurate with these regulations.

Unit operations are controlled from local stations that monitor individual operations. In addition, all instrumentation feeds the main control room from which overall plant operations are monitored. Temperature (24 stations) and pressure (four stations) controls guide operation of the smelting furnace, and temperature and air flow are the guides for converter operation.

Offgas monitoring after gas cleaning operations and of the acid plant tail gas is routinely done, with SO_2 levels recorded. The plugging of monitoring lines for gas sampling prior to cleaning is a problem that has not yet been resolved, and this is an area receiving "maximum effort" at Inspiration.

Reference: Mining Engineering, 30 (2), Feb. 1978, pp. 157-158.

Subject: Kennecott Chooses Microprocessor Control at Utah Smelter

As part of the Kennecott Utah Copper Division's $280 million smelter conversion to Noranda-type smelting to achieve EPA compliance, an extensive and elaborate control system, using digital microprocessors with simulation and both computer and manual control capabilities, has been installed. This article describes the criteria and system characteristics upon which this selection (as opposed to analog or direct digital control systems) was based. The Kennecott system comprises a Honeywell TDC-2000 microprocessor that interfaces over twin lines to dual Data General Nova 830 process control computers located at various process stations. Three types of control are possible: (1) Central control from the main computer keyboard, (2) Local control via individual control computer inputs, and (3) Manual override at each local station. The data output includes an alarm and out-of-tolerance system as well as an information terminal. Both smelting and offgas handling operations can be simulated for personnel training and for system debugging.

This control system allows more efficient smelting operations and reduced smelter emissions.

Reference: Mining Engineering, 30 (2), February, 1978, pp. 159-160.

Subject: The Sherritt-Cominco Copper Process

Features of the Sherritt-Cominco (S.C.) hydrometallurgical process are described in a technical trilogy which defines and describes the process technology (Part I), relates the results of a 9-ton per day pilot plant campaign conducted in 1976 (Part II), and analyzes the economic and commercial implications of the process (Part III). The process is applicable to a wide range of sulfide concentrate, including low-grade materials that are not attractive for conventional smelting, and features good recoveries of metallic by-products, such as zinc, precious metals, molybdenum, nickel, and cobalt. It satisfies major objectives of environmental and plant safety and health aspects without the generation of large amounts of sulfuric acid that would require neutralization if ready markets are not available. (Most of the sulfur is reclaimed in elemental form.) Analyses indicate at least economic parity with flash smelting processes with acid production.

Principal elements of the overall process, starting with concentrates are

(1) Pelletizing and reduction roasting with hydrogen

(2) H_2SO_4 leaching at ambient pressure to selectively remove iron, which is then converted to stable jarosite waste

(3) Activation and oxidation pressure leaching to convert the sulfide to cupric sulfate

(4) Purification of the pregnant liquor by high temperature oxydrolysis to effectively remove residual iron, tellurium, selenium, and other impurities, and

(5) Electrowinning of the copper

Zinc is recovered as the sulfide from a second stage of ambient-pressure leaching. Oxidation leach residue contains precious metals, gangue, and free sulfur. The gangue is separated by flotation, and sulfur is xylene extracted, leaving the precious metals concentrate. Sulfur is also recovered from a Claus plant that treats H_2S evolved during leaching to dissolve $FeSO_4$. The H_2SO_4 needed for leaching is derived from the SO_2-rich roaster topgas.

Pilot-plant operation during a 30-day demonstration run resulted in 90 percent on-stream time, and confirmed stable operation of the S.C. process as an integrated unit. Average concentrate composition was 23.7 percent Cu,

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Reference: CIM Bulletin, 71 (790), February, 1978, pp. 105-139.
Part I: The Process, Swinkels, G.M., and Berezowsky, R.M.G.S.

27.6 percent Fe, 3.1 percent Zn, and 31.5 percent S, with 5.1 g/tonne Au and 13.8 g/tonne Ag. Cumulative extractions of 98.4 and 96.3 percent were demonstrated for copper and zinc, respectively. Based on the precious metals concentrate produced, about 96 percent recovery of silver and gold were projected. Cathode copper produced contained 10 ppm S, 3 ppm Pb, 0.2 ppm Se, and had 102 percent IACS and a Spring Elongation value of 400 mm. Roughly, 1/4 of the sulfur is removed in roasting for acid plant conversion to H_2SO_4 for leaching. Another 1/4 (approx.) reports to the jarosite waste, with the balance being recovered as elemental sulfur.

A hypothetical 75,000 tpy plant was estimated, based on the results of pilot-plant studies. As with other hydroprocesses, the S.C. process is more energy-intensive than pyro processes. However, comparisons among capital requirements, operating costs, and revenues show the S.C. process to compare favorably with flash smelting in 1977 dollars. For remote operations, without ready markets for H_2SO_4, which would necessitate acid destruction the S.C. process is even more attractive. Environmental and health constraints are readily met with the S.C. process, and more effective utilization of material resources is possible. Copper process variants using various unit operation portions of the S.C. process are discussed as possibilities.

Additional Reference: Part II: Pilot-Plant Operation, Kawulka, P., Kirby, C. R., and Bolton, G. L., Part III: Commercial Implications, Maschmeyer, D. E. G., Milner, E. F. G., and Parekh, B. M.

Subject: The Role of Computers at the Hidalgo Smelter

This paper describes the development, installation, and implementation of the computer system at the Hidalgo smelter of the Phelps Dodge Corporation in New Mexico. Considerable detail is given with a number of diagrams.

A unique application of its kind for the copper industry, the Hidalgo computer system was designed by Outokumpu Oy of Finland to control operating parameters in the production of elemental sulfur to insure maximum recovery. Phelps Dodge operating personnel also received the benefit of Outokumpu experience with computer control. The scope of the computer's capabilities as an operating tool has grown significantly since start-up of the smelter, and now includes on-line control, data acquisition, and report preparation. Judging from this paper, in addition to facilitating operational control, a most important aspect of the computer function at Hidalgo is its service as a data and reporting system. Among other features, ambient air sampling at remote weather stations reports through the computer as a check on SO_2 collection system operation at the smelter.

Reference: W. J. Chen, AIME-TMS Paper No. A 78-24.

SUBJECT: Purity of Copper Produced by Fluid Bed Electrolysis of a Heap-Leach Solution

Fluid bed electrolysis is a possible technique for the recovery of copper from dilute leach streams, eliminating the current practice of cementation or concentrating the copper in solution by solvent extraction prior to electrowinning.

Laboratory tests have been made in a partitioned electrowinning cell using copper particles in the catholyte section as the cathode. The particles were fluidized by upward-flowing dilute leach solution.

Spectrographic and metallographic analysis of copper particles removed from the bed showed that, with the exception of lead (about 5 ppm higher than normal electrorefined copper), impurities are within or very close to quality specifications, and the copper had a uniform, fine-grained structure with no impurity segregation. These tests prove that fluid bed electrolysis can recover in one step, good quality copper from the leaching of low-grade mine materials.

The potential simplicity of this process suggests lowering of environmental burdens relative to current production practice of cementation or concentration/electrowinning.

REFERENCE: C. C. Simpson, Jr., Journal of Metals, 29 (7), July, 1977, pp. 6-9.

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INDEX 1.3.8 (Ger.)

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SUBJECT: Liquid/Liquid Extraction of Copper and Nickel with a Selective Reagent

SME 529 is a highly selective reagent for the extraction of copper from acidic medium and of nickel and copper from ammoniacal solutions. It reacts with these metal ions through chelation. After a short discussion of the chemistry of the reagent and the reaction, a survey is given, inter alia, of equilibrium data, the effect of contaminating ions in the feed, and the influence of the diluents. The use of the reagent is illustrated with the results of continuous mixer/settler experiment.

REFERENCE: A. J. van Zeeuw, Erzmetall, 30 (4), April, 1977, pp. 139-145.

SUBJECT: Vibratory Mill as High-Efficiency Reactor for Copper Cementation

Tests are described for the cementation of copper with iron from a copper sulfate solution, using a vibratory mill in discontinuous and also continuous operation. The test results show that the reaction velocity in the vibratory mill is in the range of 10 to 100 times higher, compared with other conventional processes. In the course of the continuous operation cementation tests, a lower iron consumption and a higher purity of the cement copper was established, apart from the substantially higher cementation rate in the vibratory mill. The solution can be decopperized to below 1 mg Cu/l. From the planning, it could be calculated that, with large-scale technical application of the vibratory mill, the capital expenditure and operating costs can be considerably reduced in relation to conventional cementation processes.

REFERENCE: M. Esna-Ashari, E. Kausel, R. Nissen, and P. Paschen, Erzmetall, 30 (6), June, 1977, pp. 262-266.

SUBJECT: Possibility of Obtaining Selenium by Sintering

Results of investigations are presented on the possibility of recovering selenium by sintering loose selenium-bearing materials with a mixture of soda and zinc oxide as a result of which soda selenites and soda selenates are obtained. These water-soluble compounds may easily be separated from the remaining components by water leaching. The reduction of selenites and selenates with an adequate reducer leads to obtaining free selenium.

REFERENCE: Panek M. Jarosinski K., Rudy Metale, 22 (6), June, 1977, pp. 274-275 Tabl.

Subject: Flash Smelting - A World Beating Finnish Process

Almost 30 years ago, flash smelting of copper or nickel ore was introduced in Finland by Outokumpu. Today, 20 plants are in operation and five under construction throughout the world, which combine the roasting, smelting, and partial converting processes in one furnace.

Research and development has produced continuous improvement of the flash smelting process, and it is these improvements which are reviewed in this article. The research has concentrated on preheating air (to 200 to 500 C) and oxygen enrichment. A 60-70 percent increase in the flash smelter capacity has been realized with the use of 30-40 percent oxygen-enriched air. The control of the temperature and the matte grade is made easier by the use of the oxygen-enriched air, and this, in turn, allows greater flexibility to accommodate changes in concentrate grade and inpurity content.

Other research is being done on smelting of copper concentrates containing various percentages of iron, lead, or zinc. Copper concentrate with low iron content can be smelted directly to blister copper, while high-iron copper concentrate presents problems which are being researched intensively at the present time. In copper concentrate with lead and zinc content, high-grade matte is made in the flash smelter (over 70 percent copper) with the zinc and lead recovered in the slag. Reduction of the slag in an electric furnace produces, after fuming, a low-copper-content lead and zinc dust.

Research in slag cleaning is also being undertaken by electric furnace or by flotation. The combination is uneconomical; a choice between either method is very complicated. Slag cleaning by flotation is 50 percent higher in cost than by the electric furnace and copper content is 0.1 to 0.2 percent lower. Electric furnace energy consumption is more than double that of flotation; however, the electric furnace can operate in a continuous process with the flash smelting furnace. Both processes could present environmental problems, the flotation process in the disposal of tailings and the electric furnace process in the disposal of off gases.

Reference: World Mining, 31 (3), March 1978, pp. 42-43.

SUBJECT: Hydrometallurgical Treatment of Port Kembla Copper-Smelter Fume

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A laboratory investigation of the recovery of metal values from copper smelting fume was conducted by researchers in Australia. Dilute sulfuric acid leaching has been used commercially to recover about three-fourths of the zinc value as useful zinc sulfate, but substantial of the greater than \$1 million metal value of the 5500 tons of baghouse fume from Electrolytic Refining and Smelting Company of Port Kembla, N.S.W., Australia, was not treated by Hardman Chemicals, Sydney, the by-product principal. Beaker tests showed that residual zinc, lead, tin, copper, bismuth, and cadmium values can be upgraded to concentrations that would make their recovery more attractive, by additional leaching with strong hydrochloric acid. The tin value (at 2.5 percent in fume, the tin alone from the ER&S operation is worth >\$1 million/year) was the primary target of these studies.

A two-stage HCl leach dissolved essentially all of the tin in beaker tests (50-g sample). This was precipitated by oxidative conditioning and injection of zinc oxide to prepare a tin-rich concentrate which, when dried, contains 25 percent tin. This treatment also returns most of the bismuth at a concentration of about 3 percent as opposed to 0.4 percent in the original fume. Additional treatment, including zinc cementation, may be used to concentrate copper and cadmium for later recovery. Lead values are extracted from the lead-rich residue of the second-stage HCl leach by washing with boiling water followed by crystallization as lead chloride.

A flow diagram for the postulated treatment circuit was developed and shows the quantities of reagents required per metric ton of tailings remaining after the dilute H_2SO_4 leach (initial zinc removal).

10M HCl - 1425 ℓ
Hot water - 2625 ℓ
Cl_2 (28 kg) or H_2O_2 (50 ℓ)
ZnO - 142 kg
Zn dust - 40 kg

The finished liquid waste contained about 40 g/ℓ of zinc (sulfate and chloride) and 4 mg/ℓ of arsenic, the only detectable metals. With thorough washing used in the beaker tests (neither necessary nor desirable in hypothesized plant operations), the liquid effluent generation rate was 4ℓ/kg.

This report of beaker tests may be construed as demonstrating only the technical feasibility for treating fume from a specific operation for concentrating metal values for later recovery. Economic and environmental considerations were not the intent of this report and would depend on further definition and development.

REFERENCE: D. E. Giles and A. Boden, Proc. Australas. Inst. Min. Metall., (262), June, 1977, pp. 39-47.

Subject: Minicomputer Application at the Hitachi Smelter

This paper describes the use of an off-line minicomputer at the custom Hitachi copper smelter of Japan as a guide for smelter operation, for data analyses, for production scheduling, and for computation. Its primary use in smelter operation is in concentrate blending calculations, material balance, charging calculations, heat balance, and gas calculations.

The use of a conversation communication made in the minicomputer operation simplifies the computer use to such an extent that no specialized computer operator is needed. The process engineers provide the computer with concentrate and flux charge rates, flux ratio, hot blast (amount, oxygen content, and temperature), fuel oil required, waste gas (amount and sulfur dioxide content), and slag forming speed.

In 4 years of operation benefits of the minicomputer system have been (1) improved precision of operation, (2) operations flexibility, (3) lower copper loss and energy consumption, and (4) constant matte grade resulting in stable converter and refining operations. (Improved stability of operations implies more manageable environmental control with fewer upsets.)

Reference: M. Higashi, K. Ichimaru, T. Ijyuin, AIME-TMS Paper No. A 78-33.

Subject: Computerized Control of Flash Smelting Furnace

Although the flash smelting process is not critically dependent on automation, automatic control becomes more profitable for the following reasons: the process is more complicated than conventional smelting, smelting of complex concentrates is facilitated, capacity is maximized, and larger throughputs are possible.

The most important tasks that can be computer controlled in flash smelting are control of material feed mixing, furnace feed, oxygen/concentration, fuel flow, oxygen percentage of process air, furnace temperature, control of flue dusts, and furnace pressure. Computer automation of these tasks was carried out at the Kokkola Works of Outokumpu in Finland. This paper is a detailed account, using flow sheets and numerous diagrams, of the computerization at this plant.

As a result of 2 years' operation at Kokkola, a 2 percent increase in profit is projected as a result of using the computer. The main benefit in copper and nickel smelters is gained via better energy control of the blast smelting furnace and increased capacity of converters due to stabilized matte grade. At the Kokkola works, increases in capacity and minimization of sulfur losses were the primary benefits.

Outokumpu staff cite the following costs and savings (1971 dollars) associated with installation, development, and operation of the computer control system:

Investment (hardware and adaptation): $383,000

Operating costs (service and labor): $51,000/year

Direct savings (sulfur revenues and savings in fuel oil; 1971 prices): $230,000/year.

The above benefits do not consider the advantages of the computer process reporting system.

Reference: V. Appelberg, S. Ojalehto, J. Daavittila, K. Saarhelo, AIME-TMS Paper No. A 78-34.

Subject: Utilization of Computer for Smelter and Refinery Operations at Onahama

To achieve labor saving and higher operational efficiency, and to cope with the enlargement and complexities of the facilities, a computer system was introduced at the Onahama Smelting and Refining Company of Japan in 1973. This paper, containing diagrams and calculations, explains the application of the computer in the following areas: weighing and sampling control in the raw materials receiving system, furnace blending calculation for optimum reverb furnace and converter operation, contour maps of the reverb furnace bottom to show magnetite buildup, sulfur dioxide strength for environmental effects regulation, minimization of power consumption, material balance of copper and sulfur, and data storage.

Reference: M. Goto, T. Hori, AIME-TMS Paper No. A 78-2.

Subject: Comparative Analyses of Hydrometallurgical Processes

Pressures to eliminate SO_2 pollution from smelters of sulfide ores have brought to the forefront a number of hydrometallurgical processes. Extraction/refining processes using hydrometallurgy are being successfully operated in a few cases, and with less success in others.

In this article, general characteristics of hydrometallurgical processes are described (with emphasis on applicability to the extraction and refining of copper ores). Operations common to hydroprocessing are (1) feed preparation, (2) liquid-solid contact and leaching, (3) liquid-solid separation and washing of solids, (4) metal recovery from pregnant liquor, (5) regeneration/recycle of barren liquid, and (6) disposal of barren solids. Three broad classifications of hydrometallurgical processes are ammonia, chloride, and sulfuric (or nitric) acid. Ammonia-based processes are slow, and good yields are difficult to achieve. Autoclave leaching improves performance, but with attendant higher costs. Chloride processes require expensive corrosion-resistant equipment; regeneration is complex, as is the production of cathode-grade copper. Sulfate leaching is generally more simple, but requires more capitalization. Energy-intensive electrowinning is a serious cost impediment to all hydrometallurgical processes (except the recently-announced Cyprus process--a chloride process using fluidized-bed hydrogen reduction; see index 1.3.1, pp. 3-4.

In general comparisons between hydro- and pyrometallurgical practices, hydro processes are more fuel-, power-, and process-material-intensive, but less labor-intensive than pyro processes. For moderate plant sizes, bottom-line capitalization is about equal, with small plants favoring hydro processes and large plants, pyro processes. In some regards, hydro processes are more flexible, but their control is more demanding.

Pyrometallurgical processes remain the basis for most domestic operations, and are well-developed and "comfortable". The principal incentive favoring hydrometallurgical processes is the present and possible future regulatory pressure for elimination of SO_2 emissions. To make hydrometallurgical processes attractive in the face of entrenched pyrometallurgical practice, the authors opine that capitalization of no more than two-thirds and operating costs no more than about 80 percent of those associated with conventional smelting of copper will be required. These fiscal targets are not yet apparent (possible exception: see 1.3.1, pp. 3-4).

Reference: J. C. Agarwall, D. S. Davies, J. K. Kakaria, and N. L. Nemser, Paper Presented at 16th Annual Conference of Metallurgists, Vancouver, B. C., August 1977.

Subject: Vacuum Lift Refining in Copper Smelting

A research treatise describing and analyzing the results of a laboratory program to evaluate the removal of metallic impurities from blister copper, matte, and white metal by vacuum refining has been presented by Japanese researchers. The ideas upon which the laboratory studies and apparatus were based were derived from the D-H vacuum refining process used commercially for VR steel production. Experiments were conducted on melts of 4 to 6 kg; the researchers acknowledge difficulties in conducting experiments on such a small scale and gaining meaningful extrapolation to plant-scale operations. However, the results are interesting and suggest new ways of refining copper that would influence the deportment of by-product values from copper smelting and refining operations, such as arsenic, antimony, bismuth, lead, and zinc.

The experiments were conducted by evacuating a column submerged in the molten bath to subject an expanded surface to vacuum, thus selectively removing impurity metals, sulfides, and/or oxides by distillation in the closed system. The refined portion was returned to the melt by isolating the vacuum pump and pressurizing the column with nitrogen. The process was reported several times during a run, with the progression of refining (removal of impurities) monitored by chemical analysis. With a recirculation factor of about 12 (e.g., 20 lift-refining cycles in a run--a rather modest campaign compared to D-H processing of steel), roughly 90 percent of the lead, 50 percent of the zinc, 85 percent of the arsenic, 60 percent of the antimony, and 80 percent of the bismuth were removed from a 45 percent copper matte. Similar results for lead and zinc removal from blister copper were observed. Lowering of arsenic, antimony, and bismuth from blister copper (or from white metal) appeared rather less effective, but certain of the data suggested that equipment or experimental difficulties may have precluded good and stable refining in these cases.

Much of this paper is devoted to theoretical aspects of the research (thermodynamics, kinetics). The authors do, however, schematically indicate several concepts for the use of vacuum lift refining of in process copper values in, for example, a continuous flash smelting operation.

(This paper is useful for suggesting boundaries of a potentially new nonferrous refining technology. The results cannot be reliably extrapolated to potential industrial application for assessment of economic, energy, health, or environmental impacts.)

Reference: Kametani, H., and Vamauchi, C., Trans. National Research Inst. for Metals, 20 (1), January, 1978, pp. 22-59.

Subject: Automatic Anode Casting at MAGMA

The Magma Copper Company of Arizona completed in 1974 the installation of a system, designed by Outokumpu, for the automatic pouring of copper anodes. Details, with drawings of the equipment and a block diagram of the system,are included in this paper.

The system consists of a casting and weighing mechanism, a hydraulic power unit and Servo system, a control desk, and an electronic control unit. The basis of the system is an electro-mechanical weighing balance which accurately measures the weight of copper to be cast; the casting speed is regulated by a program controller and averages about 50 seconds for two anodes of 825 and 785 pounds, respectively, with ± 2 percent variation.

Refinery performance is adversely affected by anode weight variations. Before the automatic system, 100 pound variations were common, which resulted in unequal consumption time of the anodes and monthly scrap averages of nearly 20 percent. The new automatic casting system has reduced scrap by 50 percent. The copper pulled from each section (pull weight) in a 14-day period has risen steadily since the new system was instituted as has the electrolytic efficiency (92-95 percent).

The addition of an ultrafine graphite colloidal suspension in water to the mold surface has increased the anode weight, reduced anode sticking in the molds, and reduced mold wash carryover on the anode surfaces, resulting in more concentrated slimes in the electrolytic cells.

Reference: I. A. Rana, AIME-TMS Paper No. A 78-16.

Subject: Application of a Continuous Technique to Secondary Copper Smelting

A laboratory model of a continuous, single-unit furnace for smelting and converting secondary copper values from low-grade scrap and copper-containing residues has been demonstrated at the University of Birmingham, U.K. The principle of this 25 kg capacity model involves charging copper-bearing scrap and residues through a covering slag at the high end of a sloping hearth. As the scrap melts, it flows down the hearth through a reaction zone that is agitated by an air (or enriched oxygen) lance, where impurities (principally iron, aluminum, and zinc) are oxidized and partition to the sand/lime slag. Converted metal containing typically 88-95 percent copper continuously flows out of a small opening at the base of the sloping hearth. (In the first lab studies, the small unit was operated in a repetitive batchwise manner, however. Continuous operation apparently was not achieved.) Counterflowing slag is discharged through a slag port at the other end of the furnace. In lab operations, it was found that lead, nickel, and tin values report predominantly to the metal, iron, aluminum, much of the zinc report to slag, and some of the zinc value is fumed. Purity of the metal depends on blowing rate. At high blowing rates, metal contains as much as 95-96 percent copper, but copper bases to the slag were unacceptably high (>5 percent).

In this small unit, the heat required for initial smelting in trial runs was reduced by 50 percent as autogenous heating contributed significantly toward the process heat requirements. In production-sized furnaces for typical charges (which would run up to 40 to 50 percent oxidizable tramp metals and materials), fully autogenous operations seem possible in some cases, and no added fuel would be needed. In the experiments, air blowing rates varied from zero (product was typical of black metal and contained about 80-85 percent copper) to 120 ℓ/kg of charge. At blowing rates of 30 to 60 ℓ/kg, the product contained 90-95 percent copper, and approached typical secondary converter quality for feed to anode furnaces, thence to electrorefining. The effects of oxygen-enriched blows were not studied. On the basis of the studies conducted, it seems possible that blast furnace and converter technology and equipment used in secondary copper smelting could be replaced in some instances with continuous operations of this type for improved energy, materials handling, and capital efficiencies. Environmentally, direct impacts of this process should be less than those for conventional blast furnace (or reverb) plus converter practice, as fewer and smaller units should be involved. Subsequent electrorefining slimes processing technology might be adversely affected, however.

Reference: C.I.M. Bulletin, 70, 788, December 1977, pp. 122-134.

Subject: The Recovery of Secondary Copper - Its Technology and Economics

This British article broadly reviews secondary copper refining and ingot-making operations, and briefly describes R&D and emerging technology in relation to these operations. In the area of charge preparation, the removal of insulation from wire and cable by burning, pyrolysis, softening and scraping, and chopping is mentioned. Sweating to separate zinc, lead, and aluminum from bimetallic copper-bearing scrap has been enhanced by the use of a Coreco metal separator furnace. Assessments of the use of molten salt sweating operations are also briefly described.

Pyrometallurgical smelting for making certified ingot from pedigreed, high-grade scrap involves only modest refining, and is typically carried out in small reverbs, rotary, or crucible furnaces. Arc melting and induction melting is also viable. Low-grade scrap, mixed scrap, drosses, slags, dusts, and low-grade residues are treated by secondary metal refiners. Smelting and slagging are conducted in reverberatory furnaces or blast furnaces in line with converting furnaces. The impure copper product is further upgraded in anode furnaces, with the product passing to final electrolytic refining. Oxygen enrichment of blast air and fuel injection are technically attractive for their effects on thermal efficiency, production rates, and lower equipment requirement, but probably are only economical in large operations. Byproduct recovery from converting is enhanced by process adaptation according to the composition of the charge.

The Birmingham continuous smelter (see Index Item 1.7.1, page 1) is a potential alternative that might combine blast furnace and converter practice in one unit operation. The British Non-Ferrous Metals Technology Center has, since 1973, piloted an in-line, fire-refining unit based on selective slagging practice for the removal of impurities (for similar technology, see U.S. Patent 4,055,415, this issue). This technology combines converter and anode-refining steps in one unit operation.

Slag technology is discussed with regard for its potential in minimizing nonferrous metal loss to slags on the one hand, and recovery of metal values in postsmelting slag-cleaning operations. Hydrometallurgical processes are attractive for recovering metal values from effluents and residues. Where effluent treatment is required for ecological reasons, processes that reclaim marketable metal values help to offset the cost of such treatment. Specific types of scrap, e.g., copper-clad aluminum wire, are also amenable to selective lixiviation.

Reference: Metals and Materials, September 1977, pp. 45-49.

INDEX 1.9.9 (Pol.)

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SUBJECT: Economic Effectiveness of New Technical and Organizational Solutions in Copper Processing

(No abstract available.)

REFERENCE: Z. Hasinska and H. Pilcer, Rudy Metale, 22 (5), May, 1977, pp. 256-259.

Subject: Zinc-Copper Resources of Wisconsin

Discoveries in the past decade of zinc and copper sulfide ore reserves in northern Wisconsin have been put in perspective by Mudrey. The principal finds are (1) 1968 - Kennecott--a 4 percent copper lens deposit near Ladysmith contains an estimated 5 million tons of ore that could support prodcution of 11,000 tons of copper per year, (2) 1974 - Noranda--a 4-1/2 percent zinc, 1 percent copper deposit containing in excess of 2 million tons of ore, and (3) 1976 - Exxon--5 percent zinc, 1 percent copper in a very large deposit estimated at 70 million tons that could support the annual production of 160,000 tons of zinc and 35,000 tons of copper. Although Kennecott filed for a state mining permit, county legislation, designed to encourage greater revenue return from the state to local government, has blocked further development. The project is at an impasse, pending resolution of revenue distribution issues by the Wisconsin legislature.

If Exxon pursues development of their zinc and copper sulfide holding, which ranks among the larger North American sulfide deposits, it could account for a substantial fraction (∿25 percent) of the domestic zinc production by the late 1980's, with significant influence on domestic prices and balance of payments. Such an increment of domestic zinc concentrate would require a sizable increase in domestic refining capacity, as existing plants and those soon to come on-stream are geared to handle present mine production. Obstacles against revitalization of a zinc-copper industry in Wisconsin include costs and markets in view of world competition, local environmental constraints, and the tax climate and mineral policy of the state.

Reference: M. G. Mudrey, Jr., Skillings' Mining Review, 67 (12), March 25, 1978, pp. 15-19, 28.

SUBJECT: Hydrometallurgical Processing of Red Sea Sediments

Containing approximately 70 to 90 g/l of extremely fine-grained solids with close to 1 percent Cu and 4 to 5 percent Zn in the form of sulfides, Red Sea sediments may be enriched by flotation to yield a concentrate with 4 percent Cu, 30 percent Zn, 20 percent Fe, and 25 percent S. For the recovery of copper and zinc, a hydrometallurgical process was developed on the basis of laboratory tests, consisting of the following steps: Leaching of the desalinated concentrate at 110°C under oxygen pressure with recycled sulfuric acid from the zinc electrolysis, copper recovery by solvent extraction and electrowinning, purification of the raffinate and zinc electrowinning. A cost estimate for processing 300,000 mtpy of concentrates showed that the metal recovery from Red Sea sediments according to the proposed concept will only be feasible economically at metal prices distinctly above the present level.

REFERENCE: D. Neuschütz and U. Scheffler, Erzmetall, 30 (4), April, 1977, pp. 152-157.

SUBJECT: Trace Metal Particulate Emission Test Results from a Number of Industrial and Municipal Point Sources

As part of the RANN Cadmium Research Project conducted by Purdue, particulate stack emissions from a 90,000 MT/yr vertical retort zinc smelter were analyzed for metallics (copper, zinc, lead, and cadmium). Sinter plant effluent was sampled after being cleaned only by twin cyclones and also by cycloning followed by electrostatic precipitation. Coking plant stack gases were not treated, nor were the retort gases. Results were as follows:

Source	Mean Emission Factors, kg/MT Zinc Cd	 Pb	 Zn	 Cu
Sinter (cyclone)	3.2	2.2	4.8	0.01
Sinter (cyclone & ESP)	1.1	0.7	1.6	0.003
Coker	1.2	0.6	12.8	0.01
Retorts	0.03	0.2	3.2	0.001

In the sinter plant, the use of the electrostatic precipitator reduces metallics to about one-third of the level experienced with cyclone separation alone.

Particulate size analyses indicated that more than half of the metal emissions were 2 μm or less (respirable). In terms of unit production, some 2 percent of the product is discharged as gaseous effluent, with more than half of this in what is judged to be a respirable size. A significant fraction of this is lead and cadmium. It is important to note that these are end-of-pipe quantities. The paper did not deal with either concentrations, dispersion, or impact on ambient air quality.

REFERENCE: R. B. Jacko and D. W. Neuendorf, Journal of the Air Pollution Control Association, 27 (10), October, 1977, pp. 989-994.

Subject: Treatment of High Iron Containing Zinc Ore in a Waelz Plant

A plant, using the Waelz Process, for the reduction of zinc and lead ores, has recently been added to Turkey's first zinc smelter near Kayseri, Turkey. This paper describes the plant and equipment with flow sheets and data from the two test runs made before the process was incorporated into the regular smelting plant schedule.

This Waelz installation is a zinc-lead ore reduction process that uses a large excess of carbon (coke) and two parallel rotary kilns at 900-1100 C. With a diameter of 4.3 meters and length of 70 meters, the nominal load of the kiln is 371 tons per day of dry ore plus coke, limestone, and settlings. Both the zinc and lead are reduced, volatilized, and reoxidized at this temperature; the high iron content of the Turkish ores is also reduced to metallic iron.

Two identical densifying lines in parallel similar to the Waelz kilns, but smaller, accept the exhaust gas dust, Waelz oxide, zinc sulfide, and skimmings in a reroasting process similar to the primary roasting. Neither the temperature nor details of the output of this densifying process is given.

The collection of dust formed in the process, in a baghouse, and its reuse in the densifying process precludes any excessive air pollution.

Reference: K. B. Chaudhuri, F. W. Guttmann, AIME-TMS Paper No. A 78-40.

TECHNOLOGY & TRENDS
IN THE NONFERROUS METALS INDUSTRY

SUBJECT: Zinc Via Imperial Smelting Process Wins Support

The Imperial Smelting Process (ISF) has proven itself throughout the world as a competitive zinc smelting technique vis à vis the electrolytic method.

The ISF method uses the blast furnace to smelt zinc and has the ability to smelt mixed lead-zinc ores, which are increasing in prevalence, producing zinc containing 1.3-1.4 percent lead, while recovering copper, silver, and other by-products. The lower quality lead-zinc ores being mined today do not lend themselves to easy flotation and separation that precedes the electrolytic process. Consequently, the blast furnace with its lower energy costs (coke prices are lower than electricity) is expected to remain competitive, despite economic penalties associated with further refining to high-grade zinc.

Both processes have environmental control problems. Of prime importance in the ISF method, lead contamination has been overcome at considerable expense. Disposition of the gelatinous residue,formed from the jarosite process for sulfur removal, has not been solved by the electrolytic refiners.

REFERENCE: T. Walsh, American Metal Market, 85 (136), July 15, 1977, p. 7.

SUBJECT: Environmental Trace Metal Contamination in Kellogg, Idaho, Near a Lead Smelting Complex

A large lead smelting complex is located at Kellogg, Idaho, in the heart of the Coeur d'Alene River Basin. The principal source of heavy metal aerosols in the air is the main stack of the lead smelter which averaged about 11.7 metric tons of emissions per month from 1965-1973.

Following incidents of lead toxicity in children of Kellogg, a detailed survey was made. Air particulate samples were taken over a 1-year period. Core samples, to a depth of 26 cm, were taken at varying distances from the plant site, as were grass samples. Analyses of trace elements were made with neutron activation analysis and X-ray fluorescence analysis equipment.

Conclusions were that the smelter operation has been the major source of Cd, Sb, Ag, Pb, Au, Zn, Se, As, In, Ni, Cu, and Hg in soil, grasses, and the air in the Kellogg area.

The synergistic effect of these high-air concentrations of metals on humans in Kellogg should be addressed, and the body burden of these metals should be investigated.

REFERENCE: R. C. Ragaini, H. R. Ralston, and N. Roberts, Environmental Science and Technology, 11 (8), August, 1977, pp. 773-781.

SUBJECT: State and Trends of the Hydrometallurgical Zinc Extraction

The author gives a review on the process of the hydrometallurgical zinc extraction. The still existing deficiencies for the different partial processes and possibilities for solution are described.

REFERENCE: V. Wiegand, Erzmetall, 30 (4), April, 1977, pp. 135-139.

SUBJECT: Hydrometallurgy of Zinc. Recovery of the Metal from Leaching Residues: Energetic Comparison Between Hydrometallurgical and Pyrometallurgical Processes

Slime residues of electrolytic zinc plants are often treated at high temperatures by mixing them with coal to volatilize their zinc and lead content as oxides; both metals are then recovered by treating the fumes thus obtained.

Recently, other methods have been successfully introduced, based on the leaching of the slime with hot sulfuric acid: iron--which is solubilized together with zinc--is precipitated by special methods, and the solutions--consisting of zinc sulfate--is used for recovering the metal by electrolysis.

By using data drawn from already operative plants and from pilot plant experiments, a comparison is made between energy consumption of both alternative methods.

REFERENCE: G. Binetti, M. Civera, and A. Vaschetti, Metalurgia Italiana, 69 (4), 1977.

Subject: Electrolytic Recovery of Zinc From Oxidized Ores

Most primary zinc operations are based upon roasted sulfide concentrates. Various easily mined ore bodies are oxidized zinc minerals, most often associated with silica. Some processes have been developed to treat siliceous oxides, but these are typically complex and not amenable to operations on totally oxidic ores. An exception is the EZ process, demonstrated by the Electrolytic Zinc Company of Australia to process willemite ore ($2ZnO.SiO_2$) from Baltana, South Australia. Encouraged by the success of the EZ operation, New Jersey Zinc has piloted a modified EZ process for use by its Thai Zinc, Ltd. subsidiary in producing zinc from the oxidized zinc deposit at Mae Sot, Thailand. In this process, ground ore is leached with sulfuric acid to extract zinc. Siliceous residues maintain their physical stability without polymerizing to a gel when pH is maintained at about 2. Rapid neutralization precipitates silica, which is removed by filtration.

Ore, typically assaying 25 percent zinc, is ground to 65-80 percent, -200 mesh, and is cascade leached at 40-50 C with a retention time of about 4-1/2 hours. About 96 percent recovery of the zinc is achieved in 4.5 hours. Neutralization is done with basic zinc sulfate (recovered from the residue wash) and finely ground limestone to a pH of 4.5. Several filtration options were explored, each with its advantages and disadvantages. Roughly 4-5 times as much solid residue is associated with processing of the Mae Sot ore as occurs with conventional sulfide processing where most of the gangue is rejected in ore beneficiation.

The filtrate is purified by cementation to lower the copper, nickel, and cadmium contents to less than 1 ppm prior to electrolytic recovery of the zinc. The resulting cathode zinc from pilot operations contained 15 ppm lead, 6 ppm Cd, 4 ppm Cu, and 5 ppm Fe as principal impurities. Current efficiency averaged 89 percent; power consumption was 3230 kWh-a.c./m.t.

A 60-kmt plant is being planned for Tak, Thailand. Capitalization will be $800-1000/annual ton of zinc.

The environmental implications of this process weighed against those of a conventional sulfide operation include no SO_2 emissions. The major effluent will be the washed filter cake residue, largely silica and gypsum. To this will be added bleed streams containing impurities removed from the system. The bulk of the residue should require little treatment and should solidify as a stable solid material.

Reference: S. T. Wood, P. L. Kern, and N. C. Achdown, J. of Metals, 29 (11), November 1977, pp. 7.

SUBJECT: The Processing of Residual Products of the BBU Zinc and Lead Smelting Works in the Revolving Reverberatory Furnace

At the Bleiberger Bergwerks Union, the mixed oxides of zinc, lead, cadmium, and germanium are extracted from residual products of the zinc and lead ore smelting in open flame revolving furnaces. The program of operation, which was developed during long years of operation, is described and the most important working data are indicated. Because of the low metal content of the final slag, the two metallurgical plants show a favorable total recovery of metal.

REFERENCE: P. Müllner, Erzmetall, 30 (7/8), July/August, 1977, pp. 326-329.

Subject: Mechanization of Lead Cell Room Operation and Slime Treatment at Kamioka Smelter

The Kamioka lead smelter of Japan uses a conventional sintering-blast furnace process, an electrothermic slag fuming process for zinc recovery, and Betts electrolytic refining process, with a 26,700 tons production rate per year.

In 1975, a new electrolytic lead refinery began operation designed to save in labor costs (only 12 men in the cell room) and to be completely mechanized. A new shape was designed for the anode to facilitate changing. This necessitated redesign of the anode casting machine. By prevention of bending of the electrodes, both anode and cathode, determination of the most suitable electrode thickness, and control of electrolytic level, it was found possible to operate on a 6-day schedule of anode and cathode change, and this simultaneous change could be made automatically with no operators present.

The lead electrolysis produces slimes which adhere to the electrodes. These slimes contain copper, arsenic, antimony, bismuth, gold, and silver. In 1970, slime treatment modifications were made to increase capacity and reduce labor consumption. Dehydrated slime is reduced with coke to molten metal; then by a technique of sodium hydroxide reaction, chlorination, and oxidization, the various metals in the slime are separated, leaving crude silver. The largest fraction after refining this silver will analyze 99.999 percent pure while bismuth, the predominant impurity in the silver, after refining, will also analyze 99.999 percent.

The results of complete mechanization of the Kamioka smelter are the highest rate of lead production in plant history, fully automatic cell room operation, and a longer electrolysis period with large-sized cells and electrodes.

Several flow sheets, diagrams, illustrations, and tables of production data and analyses are given in this detailed description of the Kamioka smelter and new lead electrolytic plant.

Reference: S. Hirakawa, E. Nomura, T. Mori, Y. Hirayama, AIME-TMS Paper No. A 78-14.

Subject: Progress of Zinc Residue Treatment in the Iijima Refinery

With a capacity of 13,000 tons/month of electrolytic zinc (98 percent recovery), the Iijima zinc refinery of Japan is concerned with the recovery of cadmium, silver, copper, lead, gallium, and indium from the zinc concentrate. This paper examines the recovery in detail with three flow sheets included.

After sulfur dioxide leaching of the zinc residue, the copper is precipitated by hydrogen sulfide. The quantity of hydrogen sulfide is critical as separation of copper and lead becomes poor with excess gas. Lime neutralization of the filtrate produces gypsum. A second stage of neutralization, to pH 5, coprecipitates gallium and indium with gypsum. The gallium and indium are extracted and separated by organic solvent extraction. Removal of iron from the remaining neutralized filtrate (Hematite Process) is accomplished by autoclaving at 180 C with 18 atmospheres of oxygen. This process is used only at Iijima.

Flotation of the copper residue from the hydrogen sulfide precipitation with n-alkyl-triethyl-diamine separates the copper and lead. The concentrate contains 98 percent of the copper and 88 percent of the gold and silver, while the tailings contain lead. Total recovery of copper, silver, and lead are nearly 100, 97, and 83 percent, respectively.

Reference: T. Ohtsuka, T. Yamada, H. Abe, K. Aoki, AIME-TMS Paper No. A 78-7.

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SUBJECT: Flash Agglomeration of Flue Dust

A system for automatic handling of flue dusts in secondary lead smelters is described in qualitative terms in this paper. Dusts removed by filtration from blast furnace stacks are fed by a closed screw conveyer through a roof port onto a sloping hearth of the "Bergsoe Flash Agglomeration Furnace", where the particles melt, agglomerate, and flow directly to a cast iron mold. The brittle cast product easily breaks into chunks for convenient recharging to the blast furnace, thus overcoming the problem of dust recirculation when unagglomerated fires are recharged directly. This system avoids manual handling of the easily ingested fines and has significantly reduced lead uptake by smelter workers. Additives to the screw conveyor system are selected for fluxing purposes to control the remelt temperature of the agglomerate for smooth blast furnace operation. Quantities and types of flux additions vary according to the charge schedules for the blast furnace.

REFERENCE: T. S. Mackey, Australian Mining, 69 (6), June, 1977, pp. 52-54.

SUBJECT: Dry Cleaning of Aluminum Smelter Potgases with Circulating Fluid Bed and Electrostatic Precipitator

Due to the good adsorption conditons in highly expanded alumina fluid beds, a high efficiency of fluorine removal can be achieved with a small amount of alumina. After the fluid bed reactor, an electrostatic precipitator may be used under certain conditions, by means of which the main quantity of harmful accompanying elements may be separated.

REFERENCE: E. Böhm, L. Reh, V. Sparwald, and G. Winkhaus, Erzmetall, 30 (6), June, 1977, pp. 247-251.

Subject: Consolidated Aluminum's "Selee" System:
Two Syllables that Could Change Your Life

Conalco's Selee system for filtering aluminum alloys to remove nonmetallic particulates is gaining acceptance on the part of aluminum producers around the world. Heart of the process is an 80 to 95 percent open ceramic filter that is replicated from a polyurethane foam by slurry-impregnation, squeezing, and firing. The filter is a one-shot, throwaway unit that is easily inserted and removed from an inexpensive filter chamber installed in a holding furnace launder. Cast sizes may range from 15,000 to 85,000 pounds. The system cost is from $3,000 to $15,000, depending on size, operating costs are 30 to 75 percent less than other filtration systems, and product quality is very good. The system is small, energy-efficient, tamper-proof, and enjoys good operator acceptance.

It is expected that Conalco will use Selee as a core around which to design a cast-shop package, including in-line degassing and other refining technology. Presumably, this package will be competitive with the British FILD, Union Carbide's SNIF, and other systems designed to minimize the use of chlorine degassing, which has in the past presented discomfort in the plant environment.

Reference: 33 Metal Producing, 16 (3), March, 1978, pp. 49-51.

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SUBJECT: New Aluminum Process

Nitrogen degassing of molten aluminum has been developed by the British Aluminum Company and bears the acronym FILD (Fumeless In-Line Degassing). It is beginning to supplant chlorine gas and pellet degassing practice, both of which generate noxious, corrosive, difficult-to-manage plant fumes.

As described in this reference, the molten aluminum from the alloying furnace flows through a two-chambered crucible where it is sparged with nitrogen gas to remove hydrogen. The molten aluminum, under the action of its own head, percolates first through flux-coated Al_2O_3 pellets, thence through uncoated Al_2O_3 pellets to remove inclusions and entrapped flux.

Among the advantages claimed for FILD are substantial cost reduction, increased furnace productivity, and much alleviated environmental problems. In this article, however, the issues of product quality comparisons were not addressed, nor was the use of chlorine for demagging discussed. The use of chlorine for removing magnesium from recycled aluminum is large.

REFERENCE: The Indian and Eastern Engineer, 119 (4), April, 1977, pp. 179-182.

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SUBJECT: About the Appearance of a Chlorination Maximum During the Removal of Magnesium from Aluminum Melts by Gaseous Chlorination

Since the legislation of environmental protection is growing stricter and stricter, the process of magnesium removal from aluminum melts by gaseous chlorination becomes questionable, too. Investigations concerning the chlorination process have shown a chlorination maximum whose practical utilization would be a proposal to solve the problem of waste gas control.

REFERENCE: R. J. Bauer and H. Winterhager, Erzmetall, 30 (6), June, 1977, pp. 241-243.

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Subject: Continuous Extruder Thrives on Scrap

Use of a Conform machine, designed and built under license by the United Kingdom Atomic Energy Authority, will permit the Macklandburg-Duncan Company, Inc., of Oklahoma City, to continuously extrude $0.15 per pound aluminum scrap into $0.75 to $0.80 per pound weatherstripping. This year, the company expects to recycle 500,000 pounds of scrap into weatherstrip.

The acceptance of any soft metal chips, particles, powder, or rod up to 3/8 inch, by the Conform machine, should produce a ready market for scrap, thus ridding the environment of much metallic scrap and junk and, at the same time, produce a useful and saleable item from this waste.

Reference: Larry Kahaner, American Metal Market, 86 (15), January 23, 1978, p. 16.

SUBJECT: Concentration of Efficacy. The Italian Aluminum Industry Reorganized--Results of Research and Development

(No abstract available.)

REFERENCE: Metall, 31 (6), June, 1977, p. 653.

Subject: Hydrometallurgical Process for Recovery of Tin From Low-Grade Concentrates

This article describes laboratory experimentation toward developing a hydrometallurgical process for tin recovery from concentrates containing up to 20 percent tin, as typical of Cornish lode concentrates. Three major process steps (reduction, leaching, and cementation) were examined in small bench tests with tables of data given for each process.

Reduction. It was found that reduction roasting at 700 C for 1-2 hours in hydrogen produced the highest leachable SnO yield, up to 99.5 percent tin, compared with a low of only 65 percent with a H_2-CO-N_2 reducing gas mixture. Preroasting at 700 C was necessary to remove the sulfur and pelletization was important to prevent dusting during the roasting.

Leaching. Crushing of the pellet from the roasting and reduction step is essential. Hydrochloric acid was found to be the most effective leaching agent, but sulfuric acid with sodium chloride or ferric chloride (to prevent passivation of the aluminum in cementation) proved to be the most economical.

Cementation. Aluminum swarf was used to precipitate the tin from the leach solution in the ratio of 0.3 g of aluminum to 1 g of tin.

As the process is only in the laboratory stage, production implications cannot yet be assessed. In any event, potential U.S. environmental implications are negligible.

Reference: G. Holt and D. Pearson, Transactions of the Institution of Mining and Metallurgy Section C, 86, June, 1977, pp. C77-C81.

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SUBJECT: Heap Leaching will Produce 85,000 oz/Year of Dore Bullion for Smoky Valley Mining

Approximately $8 million in gold has been mined from placer and underground mines, since its discovery in 1905 at Round Mountain near Tonopah, Nevada. This year (1977) the Smoky Valley Mining Company has revived gold production at Round Mountain by heap leaching low grade ores to produce 85,000 oz/year of doré bullion assaying 67 percent gold, 33 percent silver from ore, averaging 0.06 ounce of gold per ton.

Processing includes open-pit mining, crushing to 100 percent minus 1/2 inch, cyanide-lime trickle leaching, carbon adsorption and desorption, electrowinning, and refining.

No mention is made of pollution controls at the crushers or at the electrowinning and refining sections of the plant. However, a well below the leach pads does monitor the ground water to assure that no cyanide escapes the leaching system.

REFERENCE: L. White, Engineering and Mining Journal, 178 (7), July 1977, pp. 70-72.

Subject: DeLamar Silver Mine--Third Largest in United States Now Pouring Bullion

As noted in previous news items, the DeLamar (SW Idaho) silver mine was recently reactivated by Earth Resources Company. This recent publication summarizes the mine, mill, and smelter operations.

The DeLamar silver mine is located 90 miles southwest of Boise, Idaho, and is the largest open-pit silver mine in the U.S. with an ore body of an estimated 8,000,000 tons, assaying 2-6 ounces of silver and less than 1/10 ounce of gold per ton.

Seventeen hundred tons of ore are processed by the plant per day. After crushing, cycloning, and ball milling, the slurry is given a cyanide leach and filtered. Barren solids are washed, thickened, and discarded to the tailings pond. Pregnant liquor is clarified and deaerated prior to cementation of the silver and gold values according to the Merrill-Crowe process. The resulting filter cake is smelted to Dore. Weekly production of about 50,000 ounces of Dore is shipped to Belgium for refining.

Flue gas effluents are treated in an AAF Rotoclave; solids are processed or sold, and liquids are neutralized and pumped to tailings disposal. An 11,000,000-ton tailings pond to hold all wastes from the mill and surface runoff was formed by building an embankment across a gulch. No outlet or spillway is provided; however, a flow by-pass will be constructed for safety upon abandonment.

Reference: World Mining, 30 (12), November, 1977, pp. 59-61
The Mining Record, 88 (48), November 30, 1977, p. 6.

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Subject: Flotation of Flocs of Ultrafine Scheelite

In anticipation of future needs for improved recovery from fine-grained, low-grade ores, the authors investigated shear flocculation as a means for upgrading flotation recovery of scheelite fines. Experiments were conducted on both unflocculated and flocculated pulps. Sodium oleate and sodium silicate flocculating agents combined with turbulent stirring resulted in a severalfold increase in the apparent particle size. In flotation experiments, about 80 percent of the flocculated material was floated in 8 minutes, compared with 20 to 35 percent of the dispersed fines. Flotation kinetics indicated that flotation rates of effectively flocculated material is 15 to 20 times more rapid than for dispersed material.

Direct environmental implications of this technology demonstration are negligible. However, when major technology centers become based upon ultrafine particle processing, concentrator tailings will have different character than they now have, and will gradually evolve some aspects of ecological impacts that may not be readily appreciated at present.

Reference: P. T. L. Koh and L. J. Warren, Instn of Mining and Met. Trans., Sect. C, 86, June 1977, pp. C94-C95.

Subject: New Technology Overcomes Obstacles in the Alps

The first integrated tungsten operation in Europe, owned by Wolfram-Bergban and Huettengesellschaft of Bergia, Austria, began production of paratungstate in August, 1977. The scheelite ore, mined near Mittersell, Austria, is Europe's largest deposit and assays 0.7 to 1 percent tungsten.

A major obstacle to be overcome in the development of this plant is the high altitude which necessitates that all mining be done during the summer months. The ore is concentrated to low-grade (30 percent trioxide) concentrates for processing at a remote site.

A brief description of the beneficiation process is given; a unique feature is an impact crusher which reduces boulders from 1 meter to 10 millimeters in size in one stroke, thus reducing a usual five-step process to two steps.

By 1980, all mining work will be underground and year-round operation will be possible. The end productsof the W.B.&.H. operation are tungsten powder and tungsten carbide.

Reference: Tom Walsh, American Metal Market, 86 (3), January 5, 1978, pp. 9, 16.

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Subject: New Technology Tries to Tap Tungsten Trove

Last month, the USBM began pilot-plant testing of a new ion exchange process for the extraction of tungsten from the brines of Searles Lake, California. Using the ion exchange resin HERF (hydroxyquinoline-ethylenediamine-resorcinol-formaldehyde), 95-100 percent recovery of tungsten can be realized from brine containing only 70 ppm tungsten trioxide. Elution of the resin with soda ash is followed by the addition of ferric chloride, resulting in the coprecipitation of ferric iron with the tungsten. After filtration and drying, the iron-tungsten concentrate is suitable for sale to the refiners.

Some process bugs will be addressed in this operation. Process economics will be critical. However, if an economic process for extracting tungsten from the Searles Lake brines can be developed, a major increase in domestic tungsten reserves would be realized.

Reference: Chemical Engineering, 85 (5), February 27, 1978, p. 71-72.

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SUBJECT: Minnamax Project Progressing on Schedule

Massive low-grade copper-nickel deposits in the Duluth Gabbro Complex are of ever-increasing interest as a major source of domestic nickel, with copper as a coproduct of economic necessity. Development of this recognized resource will require that rather monumental ecological problems be satisfactorily managed. The Minnamax test mining project of Amax is described in this article. A 1700-foot test shaft has been finished, and, by year end, 3600 feet of drifting will have been completed, including 2100 feet within the mineralized zone. Extracted bulk samples will be evaluated by the University of Minnesota, Lakefield Research of Canada, Ltd., and U.S.B.M.-Twin Cities. Concentrate will be tested for flash smelting in Outokumpu-Oy-type furnaces.

Prior to starting the test operations and during the project, monitoring of surface waters and groundwater is being conducted to provide a basis for evaluating environmental impacts. Six low-grade leach piles, 1600 tons each, of potential lean are (0.35% Cu, 0.11% Ni, representative of low-grade surface stacks that are anticipated) have been prepared. Leaching action on these dumps is being monitored. The environmental studies include--in addition to surface and groundwater hydrology--assessment of impacts on aquatic and terrestrial biology, soil evaluation, climatology, vegetation, and wildlife.

Trial mining assessments, including the evaluation of environmental impacts, are expected to be completed during 1981. In 1982, a decision will be made whether or not to proceed with development leading to the start of production in 1985. The potential at Minnamax is for a 15,000-25,000 ton-per-day mining capacity, with ore grades from 0.6 to 1% Cu + Ni at a 4-to-1 ratio. Initially, small operations would be open pit, but major production would be entirely from underground mining.

REFERENCE: Skillings' Mining Review, 66 (41), October 8, 1977, pp. 12-14.

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SUBJECT: Actual Problems of Dressing Low Grade Nickel Ores

The energy which is needed to produce nickel from oxides is at least twice as high as is necessary for a production from sulfides. This led to a repeated examination of low grade sulphidic ores as a possible resource of nickel. Ores of this type are to be found in many parts of the world. The enrichment of nickel from these ores leads to a number of special problems in connection with the occurring minerals of pentlandite and pyrrhotite as well as of the deadening of matrix. These problems are discussed.

REFERENCE: H. J. Roorda, R. A. Kühnel, T. Kater, and M. J. Jipping, Erzmetall, 30 (7/8), July/August, 1977, pp. 287-292.

Subject: SMM Ammonia Leaching Process for Lateritic Ore

Sumitomo Metal Mining Company has recently developed and piloted (10 tpd) an ammonia leaching process for lateritic nickel ore, which greatly improves the presently used Nicaro Process. Replacement of the dust producing multiple hearth furnaces and external reducing gas generators of the Nicaro Process with an annular vertical kiln and self-reducing, coal containing, lateritic nickel ore pellets promises to reduce capital costs, simplify plant operation, and improve nickel recovery.

Pellets, 8-20 mm in diameter, of the nickel ore and 12 percent or more coal, are heated in the annular vertical kiln for 30-60 minutes at temperatures of 700-850 C with oxygen content less than 0.5 percent. It was found that the addition of 0.2 to 1 percent sulfur raised the reduction rate of nickel by over 15 percent.

After cooling, the reduced nickel pellets are ground and leached by ammonia-ammonia carbonate. Research indicated that a Cl^- source from NaCl or NH_4Cl was effective in increasing the nickel extraction, and can reduce the leaching time by a third. The final leach product occurs as basic nickel carbonate (BNC) after removal of iron, manganese, and cobalt as sulfides and the stripping of the ammonia (aided by the addition of sodium carbonate).

Details of the laboratory and pilot plant investigation are given in this paper. Numerous graphs, data tables, and a flow sheet are included.

Reference: T. Shimizu, Y. Okajima, AIME-TMS Paper No. A 78-11.

Subject: The Kinetics of the Sulphuric Acid Leaching of Nickel and Magnesium from Reduction Roasted Serpentine

The kinetics of atmospheric pressure sulfuric acid leaching of the serpentine mineralization of reduction roasted nickel laterite of Caledonian origin has been examined in a laboratory study. (Because of high magnesium content, the serpentine or unleached layers of lateritic deposits are usually considered more amenable to pyrometallurgy practice than to hydrometallurgy. The upper, limonitic layers are more suitable to hydrometallurgy.) The objective was to evaluate the selectivity of nickel extraction compared to magnesium extraction as a function of acid strength and leaching temperature. Limonite was rejected from the ore by screening out fines. The serpentine, sized at -65 + 100, contained 1.65 percent Ni, 6.1 percent Fe, 20.2 percent Mg, and 20.4 percent Si, after having been reduction roasted to convert 85 percent of the nickel and about 40 percent of the iron to the metallic state, and to convert the serpentine to olivine.

Leaching kinetics for nickel followed a logarithmic rate law according to $-dC_{Ni}/dt = K_{Ni}C_{Ni}$, where C_{Ni} is the residual percentage of unleached metallic nickel and K_{Ni} is the rate constant. For magnesium, kinetics obeyed the expression $1-(1-\alpha)^{1/3} = K_{Mg}t$, where x is the fraction of the magnesium silicate reacted at time t, and K_{Mg} is the rate constant. Rate constants for magnesium removal from the silicate were relatively lower than those for metallic nickel leaching, to the end that leaching of the nickel was completed when the magnesium reaction was only about 20 percent complete. In this regard, ambient pressure leaching may be considered selective. However, mass-balance analysis suggested by the data presented indicates an acid utilization efficiency of only about 20 percent based on nickel recovery alone. The weight of magnesium converted to M_gSO_4 in a given leaching period was probably at least 50 percent greater than the weight of the nickel extracted. The relative rates of nickel and magnesium leaching did not vary significantly with either acid concentration or temperature.

Reference: Apostolidis, C. I., and P. A. Distin, Hydrometallurgy, 3 (2), March, 1978, pp. 181-196.

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Subject: Sulfuric Acid Pressure Leaching of Nickeliferous Limonites

The chemistry and kinetics of pressure leaching of the limonitic layer of Caledonian laterite ores was examined and reported in greater depth than has been previously available. The ore sample contained 1.73 percent Ni, 0.16 percent Co, 41.6 percent Fe, 1.5 percent Mg, 2.6 percent Al, and 13 percent SiO_2. Samples were pressure leached in H_2SO_4 to extract the nickel and cobalt at temperatures from 225 to 300 C. Variables included solids content (25 or 33 percent), acid addition (acid to ore weight ratios of 0.21 to 0.30), particle size of the ore sample, temperature, and agitation. Evaluation criteria were the completeness of nickel extraction, the rates of extraction, the quality of leachate (Ni/Fe + Al ratio), and sulfur loss to residue. The important findings were as follows:

(1) Particle size. Neither nickel returns nor leaching rate were influenced by the particle size of the ore. However, finer grinds apparently nucleated the removal from solution of iron (and perhaps aluminum) by hydrolysis.

(2) Agitation. In thoroughly mixed slurries, agitation during leaching had no effect on extraction or purity.

(3) Temperature. At 225 C, low leaching rates were found. At 250 and 275 C, about 95 percent of the nickel was extracted in the first few minutes, with the rate being somewhat greater at 275 C. At 300 C, extraction was not so high, perhaps as a result of nickel occlusion on the hydrolyzed iron and aluminum products. Cobalt extraction versus temperature was similar to that of nickel. For a given leaching time, the Ni/Fe + Al ratio (higher ratio is a better-quality pregnant liquor) was higher at 275 than at 250 C. However, loss of sulfate to the residue was greater at 275 than at 250 C.

(4) Acid/ore ratio. Higher acid/ore ratios result in more rapid extraction, but also decrease the quality of the liquor for a given leaching time. Economics dictate a careful balance between these factors.

(5) Percent solids. Solids loading for effective leaching (extracted amount and liquor quality) varies according to the temperature of leaching. At 250 C, higher solids

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Reference: E. C. Chou, P. B. Queneau, R. S. Rickard, Metallurgical Transactions, B, 8B (4), December 1977, pp. 547-554.

> loading (higher production rate) may be preferred, but at 275 C, leaching should be carried out at lower (20 to 30 percent) solids loading for optimum results. The higher-temperature, lower solids route requires 10 percent less acid for comparable extraction relative to the lower-temperature, higher solids route.

The interactions among these variables upon leaching rate, product quality, and acid efficiency have been described. In general, compared to usual practice, this study suggests that somewhat greater leaching temperature and lower solids loading would be attractive.

(The fine-tuning of leaching circuits allowed by the described technology would probably have no significant environmental impact compared to current practice involving hydrometallurgy of lateritic ores.)

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SUBJECT: Amax Nickel Refinery Approaches Full-Capacity Capability

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The first American pure nickel refinery is approaching its design capacity capability at Port Nickel, Louisiana. Amax's nickel refinery will, at full operations, produce 80,000,000 lbs nickel, 45,000,000 lbs copper, 1,000,000 lbs cobalt, and 100,000 tons of ammonium sulfate per year.

Built in 1959 to process Cuban ore, the plant remained idle until 1972 when taken over and revamped by Amax. Half of the feed now comes from Botswana, Africa, and consists of matte containing 42 percent nickel, 37 percent copper, and small quantities of cobalt. Other sources of matte are South Africa and New Caledonia.

Incoming matte is crushed, blended to control feed composition, remelted for homogenization, shotted, and ground. It is then leached at atmospheric pressure with a nickel and copper sulfate solution. About half of the nickel and cobalt are dissolved; the solids (copper and the balance of the nickel) are pressure leached. Copper is recovered from the sulfate solution by electrowinning, and dissolved nickel is returned to the first leaching stage. The nickel-cobalt solution from the primary leach is treated with nickelic hydroxide forming a precipitate of cobaltic hydroxide and nickelous hydroxide. These are digested and converted to ammine complexes. Acidification precipitates nickel as a double salt. The liquor is further purified by LIX. Autoclaving the cobaltic pentammine at 360 F and 500 psig in the presence of hydrogen produces cobalt metal powder. The nickel sulfate solution is reduced to the metal in autoclaves similar to those used in the cobalt reduction; however, hydrogen and ammonia are used, producing the metallic nickel and ammonium sulfate. The ammonium sulfate is recovered and sold as fertilizer.

The process is described in detail in the article together with a schematic flow diagram of the Port Nickel facility. During conversion of this plant for Amax's use, "Amax made certain that every feasible ecological consideration was made to avoid adversely affecting the environment of the area. Solid wastes, largely harmless iron oxides, are ponded to prevent entering area waterways. Discharge management methods, however, were not described in this article.

REFERENCE: J. L. Blanco, Skilling's Mining Review, 66 (43), October 22, 1977, pp. 1, 6-9.

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Subject: Materials From the Sea - Inexhaustible Source of Magnesia and Magnesium

This article reviews the history of magnesium production from seawater and the many industrial uses being found for the unique properties of magnesium.

The new process described, complete with flow chart, is being used in a Porsgrunn, Norway, plant, utilizing waste from the German potash industry to produce magnesium chloride from 30 percent magnesium chloride brine. The brine is purified, then carefully dried, before being converted into a solid by spraying into a prilling tower. Dehydration is completed by circulating hydrogen chloride gas through the system, producing a very hydroscopic anhydrous magnesium chloride, which is then electrolized, producing magnesium metal and chlorine. The chlorine will be piped to another plant for polyvinyl chloride plastic production.

Because this process uses no chlorination furnaces, atmospheric pollution by chlorine will not be a problem.

Reference: R. J. Dowsing, Metals and Materials, January 1978, pp. 20-26.

Subject: Environmental Impact of Deep Sea Mining

Late this year, NOAA will begin tests of the hydraulic mining system for gathering manganese nodules from three sites along the floor of the central Pacific Ocean.

These tests will not only explore the mining technique but the environmental aspects of the operation as well. As the nodules are collected, most waste material is rejected at depth, but some is discharged on the ocean surface. It is this surface discharge that will be studied extensively as to the rate of discharge, temperature, salinity, and solids concentration to estimate impacts on the marine ecology.

In later tests, it is hoped to monitor the effects of the mining operation on the sea floor by the use of underwater cameras and water samples taken along the path of the dredgehead.

Reference: Journal of Metals, 29 (11), November, 1977, p. 6.

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Subject: Seabed Mining - Background and Current Outlook: Systems, Methods

This summary sketch of the legal and technological status of mining of sea nodules is based upon papers presented at a 1977 British Royal Society meeting on the subject of "Sea Floor Development - Moving into Deep Waters".

At present, a "mine site" has been hypothetically defined as one comprising an area of 30,000 sq km with 10 kg (dry weight) of nodules/sq m grading not less than 2 percent combined nickel, copper, and cobalt. This would necessarily support operations on the order 10 to 15 kmt/day for about 25 years to make operations of the scale presently envisioned economical. Sampling to define such a "mine site" would require some 300 samples over a grid of 10 km square elements to provide 90 percent confidence of merit. Required sampling procedures and analyses are briefly discussed.

The major elements of a seabed mining operation are the collector, lifting equipment, mining vessel, and transporters. The collector typically will be a 10 to 15 meter wide drag-scoop which will accumulate the nodules and exclude clay, fines, and "boulders". Location and navigation will have to traverse the bed without overlap or coverage gaps. Based on the presently available state of technology, first-generation mines will yield about 25 percent of these nodules and the second, about 40 percent, hopefully. Direct mechanical bucket lifts, buoyant-lift units, and combined hydraulic-mechanical lifts are possibilities. The mining vessel will typically be a 45,000-ton displacement unit designed for an on-site tour of, say, 4 years and a transport fleet (three or four, 65,000-ton displacement vessels) for crew, supplies, and product transportation. Probable power requirements will be on the order of 40 to 50 megawatts, which suggests a shipboard nuclear power plant.

The expenditure required for such operations mandates an international legislative framework to provide long-term security of the investment. Points of view of various national factions relative to the Law of the Sea dealing with sea-mining ventures are recapped in the article.

Reference: World Mining, 30 (13), December, 1977, pp. 54-58, 80.

Subject: Optimization of Polymer Flocculation of Heavy Metal Hydroxides

Acid mine water is the major heavy metal-laden aqueous discharge associated with the nonferrous metals industry. Lime-and-settle methods are used to reduce heavy metals to acceptable levels where these wastes are discharged. The poor settling characteristics of metal hydroxides may be combatted by flocculation with polymer additions. To improve the technical basis of polymer flocculation, this laboratory research was conducted by McMaster University, Hamilton, Ontario. The conclusions from the research were

- Mixing conditions are more important than polymer properties in the flocculation of neutralized mine water.
- The degree of polymer hydrolysis had no effect on the flocculation of iron-, zinc-, or copper-bearing mine water.
- Mixing time and speed vary indirectly and directly, respectively, with mine water strength.
- At a metal: sulfate ratio of about 0.3, the optimum polymer dosage is about 0.5×10^{-3} times the sulfate concentration.

Reference: P. M. Huck, K. L. Murphy, C. Reed, and B. P. LeClair, J. of Water Pollution Control Federation, 49 (12), Dec. 1977, pp. 2411-2418.

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SUBJECT: Environmental Problems of Tailings Disposal

This is the second of three articles by the authors (see 15.1.8, page 1).

All mining operations need to eliminate some waste, thus creating major environmental problems of tailings disposal. These problems involve safety and stability, aesthetic nuisance, air and water pollution, and land reclamation. The release of water from impoundments is probably the single, most serious, and widespread problem associated with terrestrial disposal, and this method of disposal is likely to be the predominant one used for many years to come.

Terrestrial impoundment is discussed in depth in this article, with diagrams of pond construction and flow sheets of water used in various mining operations, cost comparisons of stabilization methods, and landscaping and reclamation details.

Lake, river, and marine disposal is examined with reference to use and pollution in specific areas of the world. Underground disposal by deep-well injection is mentioned briefly.

In the future, research and development will be concentrated on control of water flow in impoundments, chemical treatment of effluents, and revegetating the most acidic, toxic tailings. Marine disposal will receive greater attention because of the prospects of ocean mining.

REFERENCE: C. G. Down and J. Stocks, Mining Magazine, 137 (1), July, 1977, pp. 25-33.

SUBJECT: Positive Uses of Mill Tailings

This is the third of three articles by the authors (see 15.1.8, page 2).

The most satisfactory solution to tailings disposal is to find economic uses for them; however, the sheer quantity of these tailings presents the largest obstacle to their utilization.

Recovery of additional values by reprocessing, use as a backfill material, and use as a raw material to make higher value products are the three major uses of tailing material. Each use, and problems encountered, is examined in detail with typical examples taken from mining areas throughout the world.

A considerable amount of research and development has been expended on the use of tailings but almost none on the use of the tailings disposal area. Almost all disposal areas that have been developed have been made into recreation areas or wildlife sanctuaries by revegetation. However, the long-term viability of such schemes is questionable in view of the toxicity of many deposits.

Because of the continued strength of the environmental lobby, pressures will grow to ensure that tailings be utilized in bulkfill or upgraded applications.

REFERENCE: C. G. Down and J. Stocks, Mining Magazine, 137 (3), September, 1977, pp. 213-223.

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SUBJECT: Pollution Control at Western Mine's Myra Falls Operations

The Western Mines Limited is currently mining and milling some of the most complex polymetallic ores in British Columbia in Strathcona Park near the center of Vancouver Island. The ore contains recoverable quantities of copper, lead, zinc, gold, silver, and cadmium. This presents one of the most complex milling problems requiring close control of grind, pulp density, pH, and reagents. And, because the plant is located in a park, stringent limitations are placed on the tailings discharge.

Tailings have been and are being dispersed by cyclone separation for mine backfill (~ 50 percent) and by deep discharge below the thermocline in nearby Buttle Lake. Daily assays of the tailing stream, and monitoring of the lake, fish, and appurtenant waters, are conducted.

Commencing in 1973, the processing of a lead-rich ore body required cyanidation for lead-copper separation. At that time, a basic chlorination cyanide-breaking circuit was installed. The size of this circuit (~ 250,000 gpd) required a much larger scale of operation than, for example, similar cyanide destruction circuits associated with industrial metal-finishing operations. Chlorination occurs in three large tanks arranged in series to allow the 1-1/2-hour treatment time to destroy the copper cyanide complex at flows up to 10,000 g/hr. Lime is injected prior to chlorination to maintain the pH at 10.5 or greater as required to precipitate the copper, drive the cyanide oxidation (to cyanate) to completion, and to prevent the escape of toxic CNCl.

Chlorine is provided as tank gas. The use of 1500 lb/day caused difficulties with refrigeration and loss of Cl_2 pressure, which was magnified at ambient temperatures <50 F in the Canadian clime. Western Mines accordingly found it necessary to install an evaporator to maintain adequate feed during chlorination.

The chlorine feed is controlled automatically by continuous monitoring of the oxidation-reduction potential to ensure system stability on the hypochlorite side. An ORP setting of -600 mv was found to allow this condition.

The installation and establishment of operations of the chlorination plant has allowed Western Mines to maintain heavy metal and cyanide concentrations in effluents of less than specified maxima in their most recent operating permit. This report, however, alludes to analytical disagreement between laboratories. Improvements in sampling practice, preservation of samples, and standardization of assay practice have improved interlaboratory agreement, although cyanide analyses remain as an area of concern that is yet to be resolved.

REFERENCE: A. G. Eccles, CIM Bulletin, 70 (785), September, 1977, pp. 141-147.

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SUBJECT: Continuous Monitoring of Froth Level and Pulp Density Helps Mineral Efficiency by Computer Control

The Noranda Research Center has developed a froth level monitor and a pulp density meter, the output of which can be used by a computer to control the froth level and pulp density of a beneficiating process for a number of metallic ores.

The froth level controller consists of a set of stainless steel electrodes of decreasing length so that at least one is always immersed in the froth. An electronic circuit senses the number of electrodes in contact with the froth and produces a dc output signal which is an accurate linear function of the mean froth level. This signal can be used as an input to a control system.

The pulp density meter consists of two pressure chambers which transmit hydrostatic pressure to a differential pressure transducer where the pressure is converted to an electric signal for readout on a calibrated scale or as input to a control system.

The two instruments are proving to be of value to several Noranda group concentrators and to others where it has been installed, offering increased automation and improved metallurgical control.

Automation allowed by such instrumentation leads to lower process losses, cleaner plant operations, and decreased pollution by spills and other fugitive emissions.

REFERENCE: F. Kitzinger, F. Rosenblum, and P. Spira, The Northern Miner, 63 (22), August 11, 1977, pp. 12-13.

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Subject: Sulphide Mineral Electrolysis

This review of processes for the direct electrolysis of metal sulfides to metal and free sulfur admits to the ideological desirability of such processes, particularly in light of present air pollution constraints in developed countries. However, its main theme is that, in most cases, the complexities of cell operation and electrolyte purification, even when technical feasibility can be shown in the laboratory, are such as to make direct conversion processes uneconomic. An exception is the operation by International Nickel Company, Ltd., of the Thompson, Manitoba, works for nickel production.

Reference: T. Biegler, Chemistry in Australia, 44 (8), pp. 193-197.

Subject: Impact of Environmental Control Expenditures on Copper, Lead, and Zinc Producers

Recent past capital expenditures toward compliance with pollution abatement regulations have added considerably to the burdens of primary copper, lead, and zinc producers. This article summarizes an independent survey conducted by National Economic Research Association, Inc., with the cooperation of major nonferrous primary metal producers.

Since 1970, about 40 percent of the copper industries' capital expenditures have been for environmental control equipment. For lead and zinc producers, this figure approaches 30 percent. Similar or greater expenditures will be required through 1985, according to expected EPA implementations, if nonferrous metal producers are to maintain compliance. Considering world competition, the return on investment will shrink from about 12 percent to about 7 percent, which will hardly attract investment needed to even maintain the current industry, let alone provide for the expansion of the domestic industry to meet domestic demand.

As an example of current trends that bode ill for the domestic nonferrous metals industry, the supply elasticity for domestic copper is estimated at +0.6 (i.e., a 1 percent increase in price effects a 0.6 percent increase in supply) versus +1.2 for the rest of the free world. In a free-trade structure, the domestic copper industry is becoming less competitive with the rest of the free world, due in major part to U.S. environmental compliance requirements that are not extant in other major copper-producing countries.

It would seem that the domestic nonferrous metals industries, which have been impacted more severely than other major domestic industries by EPA regulations, are doomed to wither with the net result that the U.S. will become more and more dependent upon foreign supply for these necessary materials. Recent trends in the copper and zinc industries may be mere harbingers of things yet to come.

Reference: B. I. MacDonald and M. Weiss, Mining Congress Journal, 64 (1), Jan. 1978, pp. 45-50.

Subject: Hot, Dirty SO_2 Handled in Mild Steel

The processing of sulfidic ore by Inco at Copper Cliff (Sudbury), Ontario, presents a problem of handling the hot sulfur dioxide that is produced. Two gas streams, one containing 12 percent and the other 80 percent sulfur dioxide, must be cleaned and processed into sulfuric acid and liquid sulfur dioxide.

Three units used in the operations are described in detail. With the temperature of the sulfur dioxide reaching over 2000 F in some parts of the equipment, corrosion was a major problem. Although a number of alloys were tried, refractory lined carbon steel remains the most cost effective. Other alloys tested were Inconel 601, 801, and 814 and 316 and 430 stainless. Although such materials are more corrosion resistant, they are more expensive, and lined carbon-steel equipment is preferred for economic reasons.

Reference: C. F. Baxter, Canadian Chemical Processing, 61 (12), December, 1977, pp. 30-32.

SUBJECT: Solvent Extraction in Hydrometallurgy

Solvent extraction is today one of the most important processes in hydrometallurgy for the separation, purification, and concentration of metal ions. This process is being used commercially for the production of vanadium, tantalum/niobium, zirconium/hafnium, uranium, zinc, beryllium, tungsten, copper, nickel, cobalt, and the rare earths. Developments nearing commercial application include metals of the platinum group, molybdenum, and rhenium.

This recent review presents a summary of solvent extraction information, primarily devoted to copper, with a lesser amount concerning uranium and the other metals. A list of solvent extraction reagents is given with their uses; copper plants and nickel and cobalt plants throughout the world using solvent extraction are given. Schematic flowsheets of processes of solvent extraction for copper sea nodules and for uranium are included.

Future developments in solvent extraction are inevitable, and its future in hydrometallurgy is assured.

The use of solvent extraction hydrometallurgy will do much toward elimination of sulfur dioxide emissions which are inherent in many older pyrometallurgical techniques.

REFERENCE: D. S. Flett, Chemistry and Industry (17), September 3, 1977, pp. 706-712.

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SUBJECT: The San Telmo Process, a Hydrometallurgical Route for the Recovery of Copper and Zinc from Complex Sulfide Ores

The frequently observed weathering of sulfide minerals under ambient conditions has led to a systematic investigation of their leaching behaviour. From these tests, a process has evolved which is characterized by a cyclic heap leaching operation with a controlled oxidation of pyrites containing copper and zinc. Both metals are recovered from a closed leach liquor circuit by solvent extraction with liquid organic ion exchangers and subsequent electrowinning.

REFERENCE: M. J. Meixner, Erzmetall, 30 (5), May, 1977, pp. 204-208.

Subject: Chloride Metallurgy Developments Enabling Treatment of Complex Zinc-Lead Sulphides

Large, mixed zinc-lead-copper sulfide ores in New Brunswick and elsewhere in Canada do not respond well to selective flotation. CANMET has conceptualized a chloride hydrometallurgy flow sheet for such ores, and has done small-scale bench tests to verify certain unit operations. In this process, typical bulk ores (30% Zn, 20% Fe, 4% Pb, 0.7% Cu, and 40% S) are chlorinated, with elemental sulphur or SCl as a byproduct. The metal chlorides are roasted to oxidize the iron to Fe_2O_3 and recover some chlorine for recycle. Solids are water-leached to dissolve zinc and copper chlorides, and after liquid-solid separation, the residue is brine-leached to remove the lead chloride. Zinc- and copper-bearing liquor is passed through staged LIX to separate zinc from copper, and, after stripping, the respective metals are electrowon, with barren liquors recycled to leaching or stripping stages. Lead values from brine leaching are crystallized (and/or LIX-treated, according to purity demands), and electrowon.

This is conceived as essentially a closed process with the major water and gas streams contained and recycled. In addition to zinc, lead, and copper as coproducts, iron oxide and sulfur are visualized as byproducts. The waste tailings, largely silicates, would contain typically 0.1% zinc and sulphur, and 0.2% copper and lead, and should be environmentally acceptable.

The selection of corrosion-resistant materials, continued study of unit operations, design of special equipment, environmental controls and processes, and cost evaluations are included in the list of priorities in continuing the development of this process by CANMET in Ottawa.

Reference: H. W. Parsons and G. M. Ritceg, The Northern Miner, 63 (37) November 24, 1977, pp. D20-21.

SUBJECT: Humboldt Wedag's Cyclone-Furnace Smelting Recovers Nonferrous Metals

Designed by Humboldt Wedag of Germany and the Metal Research Institute of U.S.S.R., a cyclone-furnace smelting process has been developed which, for low capital investment and low operating cost, will recover metal from low-grade nonferrous ores, oxide or sulfide concentrates, and slags and residues.

The process is based on a compact, continuous operating cyclone-furnace smelter, which can use any fuel or atmosphere and reaches 1200-1600 C in temperature. High-vapor-pressure metals are volatilized as elemental metal or as metal compounds and are collected in a baghouse for refining. Those metals that cannot be vaporized are upgraded to a matte.

Two plants using this process are located in Bolivia. The first is used to recover antimony at a yield exceeding 96 percent. The second plant will be used to upgrade low tin content concentrates when operations begin in 1979. Lead-bearing furnace slags and residues from zinc leaching can be processed, in addition to the tin.

Current maximum throughput in furnaces of the Humboldt Wedag design is about 300 tons per day, but this can be increased several times by using parallel cyclone furnaces with only one waste gas system and electric furnace.

Waste gases pass to a baghouse or electrostatic precipitator or both to recover the metal oxide dusts. The molten products are collected in a heated settling furnace.

(Operating specifics and ancillary facilities are not described.)

REFERENCE: Engineering and Mining Journal, 178 (10), October, 1977, pp. 45, 49.

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Subject: Processes to Refine Ocean Nodules Assessed

Although the cost of mining ocean nodules is still debatable, it is believed that the costs associated with onshore processing will be about twice those for mining. Two methods of processing are being assessed and the decision is still open.

The Kennecott process reduces the ground nodules with carbon monoxide at low temperature and pressure. An ammoniacal leach solubilizes the copper, nickel, and cobalt, while the tailings contain the manganese. Liquid ion exchange removes the copper and nickel; sulfide precipitation removes the cobalt.

International Nickel's pyrometallurgical process dries the nodules (not ground) in a rotary drier, then prereduces them with coal in a rotary kiln, before smelting in an electric furnace. Manganese is concentrated in the slag, copper, nickel, and cobalt in the matte. The matte is given a hydrometallurgical treatment with ion exchange and electrowinning similar to the Kennecott process. Gas from the dryer in the pyrometallurgical process is cleaned with an electrostatic precipitator. Any sulfur dioxide produced in drying is absorbed by the nodules, and is of no environmental concern.

For a 5000-ton-per-day nodule input, the capital cost required of the pyrometallurgical process would be $400-500 million, with yearly operating costs of $100-150 million, while the hydrometallurgical plant would cost $70-120 million to operate yearly after a capital investment of $250-350 million.

Reference: Chemical and Engineering News, 56 (12), March 20, 1978, pp. 22-23.

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SUBJECT: Recovery of Nonferrous Metals Using Magnetic Fluid Techniques

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Colloidal suspension of magnetic particles in a fluid allows applied magnetic fields to impart fluid characteristics best described as "apparent density". This has held promise for use in the field of heavy-media separation. Magnetite (Fe_3O_4) particles, 100 Å in diameter, when coated with a surfactant such as oleic acid form a colloid in water, kerosene, or other suitable fluids.

Hitachi of Japan has developed and demonstrated a system utilizing magnetic fluid separation of metal values from scrap automobiles. After magnetic separation to remove iron and steel, shredded automotive waste was processed to recover 84 percent of the aluminum value at a purity of 95 percent, all of the lead, 81 percent of the copper at 98 percent purity, and 94 percent of the zinc at 90 percent purity.

The processing of discarded consumer products and even municipal wastes through such a unit would separate valuable resources to allow economical recycling as well as significantly lower the land burden of solid waste disposal.

REFERENCE: S. Nogita, T. Ikeguchi, K. Muramori, S. Kazama, and H. Sakai, Hitachi Review, 26 (4), April, 1977, pp. 139-144.